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PROGRESS REPORT ON RESEARCH AND RELATED SERVICE
APPLICABLE TO
VEGETABLES

Including Work in United States Department of Agriculture
and Certain State Work Financed in Part with
Agricultural Marketing Act Funds

Prepared for Use in Connection with the
February 1955 Meeting of the
Vegetable Research and Marketing Advisory Committee

.....
This progress report is a "tool" for: (1) administrative use in
program development, coordination and evaluation; (2) advisory com-
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UNITED STATES DEPARTMENT OF AGRICULTURE
Washington, D. C.
January 1955

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Abbreviations of Agency Names

USDA agencies responsible for conducting or supervising the work covered in this report are indicated by initials as follows:

AE	Agricultural Engineering Research Branch	(ARS)
AEC	Agricultural Economics Division	(AMS)
AES	Agricultural Estimates Division	(AMS)
APH	Animal and Poultry Husbandry Research Branch	(ARS)
DU	Washington Utilization Research Branch	(ARS)
ENT	Entomological Research Branch	(ARS)
EU	Eastern Utilization Research Branch	(ARS)
FAS	Foreign Agricultural Service (Independent)	
FCS	Farmers Cooperative Service (Independent)	
FES	Federal Extension Service (Independent)	
FS	Forest Service (Independent)	
FV	Fruit and Vegetable Division	(AMS)
HC	Horticultural Crops Branch	(ARS)
HE	Home Economics Branch	(ARS)
HN	Human Nutrition Branch	(ARS)
MRD	Market Research Division	(AMS)
OES	Office of Experiment Stations	(ARS)
PE	Production Economics Research Branch	(ARS)
PPE	Plant Pest Control Branch	(ARS)
PQ	Plant Quarantine	(ARS)
SDA	Liaison Office, Commissioners of Agriculture	(AMS)
SU	Southern Utilization Research Branch	(ARS)
SWC	Soil & Water Conservation Research Branch	(ARS)
WU	Western Utilization Research Branch	(ARS)

COOPERATION

Much of the research on vegetables covered in this report, particularly that relating to production is conducted cooperatively by the USDA bureaus and the State Agricultural experiment stations. This cooperative effort usually begins with the inception of the need for a job from farmer and industry contacts and extends by joint planning of work programs, cooperation in doing the research job and, finally, making available the results on the joint effort. The detailed arrangements for the cooperative work vary considerably, depending upon the available facilities, financial support, and personnel and the State policies involved. In principal, the cooperative efforts by the USDA and the State stations are planned so as to utilize to the best advantage the personnel and facilities of both agencies and to assure coordination of effort. In most of the reports which follow, the detail required to explain specific cooperative relationship is omitted.

Most marketing service and educational work covered in this report also involve varying degrees of cooperation between the USDA, State Departments of agriculture and bureaus of markets, State Extension Service and industry groups.

FUNCTIONS OF ADVISORY COMMITTEES

The Vegetable Research and Marketing Advisory Committee is one of a number of committees authorized by Congress in 1946 to advise the Department of Agriculture with respect to specific research and service programs.

The committees have been asked to consider all of the research and marketing service work of the Department in their respective fields. This is in recognition of the value the Department places upon the advice and counsel received and is in accord with suggestions of Congressional committee members who are directly concerned with the work.

These committees are performing an important function, in advising with respect to the development of the Department's research and marketing service programs. However, it is recognized by members of Congress, committee members, and the Department that the implementing and administering of those programs are the responsibility of the Department.

The functions of the advisory committeemen include:

1. Acquainting themselves with the problems of producers, all segments of the industry and of other groups, and presenting them for committee consideration.
2. Reviewing and evaluating the current research and marketing service programs of the Department, including work under way at Federal laboratories and field station.
3. Recommending adjustments in the Department's program, including priorities for new work and expansion of work under way.
4. Developing a better understanding of the nature and value of the agricultural research program, explaining it to interested persons, groups and organizations and encouraging the wider and more rapid application of the findings of research.

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I. PRODUCTION RESEARCH

A. Progress on Work Under Way

PLANT INTRODUCTIONS - HC

Progress and Findings - During the reporting year, 1,389 introductions of vegetable seeds were processed for experimental evaluation by State and Federal Experiment Stations.

The Windsor Longpod bean was introduced from Australia in 1949. A selection of this variety, made by the Louisiana Experiment Station, has performed so well in Louisiana tests that it may soon be released for commercial trial.

Three celery introductions, collected in Turkey in 1949, have shown high resistance to early blight of celery Cercospora apii in tests at the New York Experiment Station and represent valuable breeding material. They are outstanding in having large stems in proportion to total top growth and better flavor than thirteen other celery introductions tested.

The "Elmsfever" rhubarb variety, introduced from Germany in 1938 and tested at Michigan State College, has been outstanding with respect to red color. The red pigment extends into the center of the petiole. When cooked, the variety makes an attractive red sauce and pie. At the completion of canning and forcing tests now under way, the variety may be recommended for commercial planting.

In an evaluation of 1938 Ecuadorian tomato introductions, furnished by the Florida Experiment Station, they have found one that is immune to gray leaf spot, early blight and phoma rot. These valuable plant genes are now available to breeders for utilization in development of desirable varieties containing resistance to these diseases.

About 150 clones of sweetpotato and extensive collections of sweetpotato seeds collected in 1953 have been distributed to Federal and State cooperators who are now determining disease resistance and other properties of these materials.

Plans - Work will continue approximately as at present, provided there is no significant change in resources.

- A. Proposal for Committee Consideration - A National Seed Storage Laboratory should be developed for the purpose of preserving collections of foreign and domestic plant species, varieties, and strains that are becoming difficult to obtain and also for preserving valuable existing stocks in the hands of breeders. This facility should be operated by Plant Introduction Section which now has responsibility for plant collections.

Publications

Report of National Screening Committee for Disease Resistance in Tomato. L. J. Alexander, and M. M. Hocver. NC Regional Bulletin to be issued by Ohio Agricultural Experiment Station.

BREEDING, GENETICS, AND EVALUATION - HC

BEANS

Progress and Findings - Beans in the South. Some resistance to common blight is reported. Over 400 selections now show desirable horticultural properties combined with differing degrees of simultaneous resistance to powdery mildew, rust, blight and virus diseases.

Although white-seeded snap beans tend to have low vigor upon germination and early growth, several white-seeded lines exhibit strong germination and early growth. These were selected out of nearly 900 lines tested against soil organisms that reduce stand.

A new line has been selected which has an even lower rate of moisture loss from pods after harvest than does the Wade variety--noteworthy for ability to resist wilting after harvest. It loses only about half as much in unit time as does Tendergreen or Contender.

The association between seed-coat color and degree of greenness in fresh pod color is under study. Generally, depth of greenness decreases in the following order of seed-coat colors: Purple, buff, black, brown, "soldier," mottled, white. A white-seeded line was found to have nearly the highest content of chlorophyll of any of some 800 lines. This represents an important break in the linkage between white seeds and less intense green pod color; and will aid improvement of white-seeded snap beans.

Mosaic resistant line B2884 gave rise to the Seminole variety selected from it and introduced by the Florida Experiment Station.

Breeding line B2254 has been released to the Maryland Experiment Station for introduction under the name of Calvert.

Work is continuing on the easy-picking character and several lines have been selected which possess it.

Work also continues for elimination of the undesirable ruptured seed coat character that has been present in many of our stocks. Over 60 advanced breeding lines are now apparently free, and some 650 others showed an average of less than one-half of 1 percent.

Beans in the North and West

Dry beans - Three new Great Northern and 3 Pinto types resistant to several strains of rust and 2 virus diseases were tested in 7 States for the third year. Upon analysis of results the best one of each type will be introduced if superior to present lines. (Cooperative with Montana, Colorado and Nebraska).

Two additional Pinto beans resistant to curly top and 2 other viruses have performed very well in 1953 and 1954. If 1955 tests are as favorable, one bean will be introduced in 1956, mainly for the Columbia River Basin. (Cooperative with Washington).

Of 17 superior-appearing anthracnose-resistant new beans of Michelite type the 3 best were increased in Florida last winter for commercial tests in 1954, looking to release of one in 1955. Bad weather in 1954 rendered the tests inadequate, so that release must be delayed at least a year, pending outcome of tests in 1955. About 25 mosaic resistant selections were also delayed in development by the bad season in 1954.

From Michelite crosses resistant to 2 viruses and 3 strains of anthracnose about 13,000 selections were made for evaluation and further selection in 1955.

A genetic linkage between seed coat color and mosaic susceptibility in Yellow Eye, Cranberry, and the Red Kidney types developed in the East is delaying development of suitable resistant types, although rapid progress is being made in developing anthracnose resistance in them. Anthracnose resistance and curly top resistance were found to be linked. (Cooperative with Michigan and New York).

In Western types of Red Kidney, resistance to mosaic and to mosaic and curly top combined is progressing satisfactorily. About 3,000 crosses were made in 1954 for producing a multiple virus resistant Red Mexican bean for the Northwest. (Cooperative with Washington and Idaho).

Snapbeans - Eight new slender round-pod snap beans were sent to 32 seedsmen, processors and investigators for over-all evaluation in 1954. Incomplete returns indicate some of the eight are superior to present commercial varieties. These have all been increased for further testing in 1955 with a view to release of the best one or two in 1956 or 1957.

Of 10 new lines of Stringless Black Valentine type resistant to pod mottle and 2 other viruses one approached desired type and in Florida far outyielded Asgrow Black Valentine.

A curly top resistant Blue Lake type was introduced to the public under the name of Columbia--the first high quality, curly top resistant snapbean.

Good progress is now being made on curly top resistance in round, oval, and flat-podded snapbeans. About 1,800 resistant selections of fairly good type were made in the Columbia River Basin work in 1954.

Progress is satisfactory in developing mosaic resistance in flatpodded and in white and green-seeded round-podded types for processing; also in developing southern bean mosaic resistance in flat, oval, and round-podded snap bush beans.

Lima beans - Three downy mildew resistant limas of Thorogreen type showed very satisfactory yields and freezing qualities in commercial-scale tests in New Jersey. Winter increase of seed in Florida is planned for further tests in 1955.

Two promising nematode-resistant limas of Thorogreen type gave high yields and processing qualities, one of which will probably be released to seedsmen in 1955 for increase.

Plans - Work will continue along present lines.

Publications

Inheritance of resistance to the variant strain of the common bean mosaic virus. A. L. Andersen and E. E. Down. (Abs.) Phytopath. 44:481- 1954.

A rapid method of testing snap beans for resistance to common bean mosaic virus. H. R. Thomas and H. H. Fisher. Plant Dis. Rptr. 38:410-411 1954

A progress report on breeding lima beans for resistance to downy mildew. R. E. Wester, H. R. Thomas and H. Jorgensen. Proc. Tri-State Packers Assoc. Feb. 1954 (In press).

A nematode-resistant bush lima bean. R. E. Wester, A. L. Taylor and P. H. Massey, Jr. Proc. Tri State Packers Assoc. Feb. 1954 (In Press).

Snap bean breeding studies of the U. S. Department of Agriculture. W. J. Zaumeyer, Seed World 74: 7. Apr. 2, 1954.

Snap beans for marketing, canning and freezing. W. J. Zaumeyer. Farmers' Bulletin No. 1915 Revised. Sept. 1954.

Report of the Cooperative Dry Bean Nurseries 1953. Bean Project, Vegetable Crops Section. Processed report, March 1954.

CABBAGE

Progress and Findings - 1954 Recommendation "Expand breeding and disease research on vegetable crops to include --- expansion of present breeding programs on --- cabbage. 5/13

The cabbage breeding program in the South is being stepped up primarily through employment of additional subprofessional workers and increased support of field and laboratory work.

In the South - About 235 selections were made at Charleston combining good horticultural type with resistance variously to downy mildew, alternaria leaf spot, yellows, and all resistant to cold and premature bolting. All lines have been tested in the greenhouse against yellows, alternaria, and black rot. An introduction from South Africa was found to be resistant to yellows, black rot, and alternaria and tolerant to downy mildew. One selection is resistant to both yellows and alternaria.

Breeding lines varied from 40 to 63 mg/100 gm. of vitamin C and single heads varied from 30 to 70 mg./100 gm. The line highest in vitamin C is related to the line most resistant to downy mildew.

Studies were continued also on inheritance of undesirable leaf and plant characters to learn how to minimize their occurrence in commercial varieties. Genes for "notch" leaf and related characters tend to prevent expression of the hereditary "whiptail" condition. "Balloon rosette" and flat rosette (non-heading characters) are inherited independently of notch and whiptail, but the two rosette shapes appear closely related. Great differences in hereditary size of plants occur both among and within lines having undesirable leaf and plant forms. The relation of plant size to these abnormalities remains to be determined.

In the North - Further slow progress was made in developing commercial varieties resistant to club-root. Selections are proceeding for both late, storage Ballhead types and for mid-season types that will be resistant.

Breeding for combined tipburn resistance and wilt resistance was continued.

Plans - Work will continue along present lines but on a modestly expanded scale in the South.

Publications

Badger Market, a new disease resistant cabbage. J. C. Walker, R. H. Larson and G. S. Pound. Phytopath. 43:649-650. 1954.

LETTUCE

Progress and Findings - 1954 Recommendation, "Expand breeding and disease research on vegetable crops to include --- expansion of present breeding programs on lettuce, ---." 5/13

The lettuce breeding program is being modestly expanded. A plant breeder has been moved from Beltsville, Md., to the Central California district to work in a new three-way cooperative program involving the Department, the lettuce industry, and the California Experiment Station. It is believed that this new arrangement, together with resources furnished by the industry, will promote the translation of basic work of the past several years into more and better new varieties of lettuce. The new work is only now becoming established.

A second new cooperative arrangement has been recently completed for lettuce breeding in Texas, initially in the Lower Rio Grande Valley. The Department, the Texas Experiment Station, growers and shippers, and transportation agencies are involved. This expansion has been possible chiefly through resources provided by Texas producers and the transportation agencies referred to.

In the West. Numerous crosses have been made between Great Lakes types and Imperial types in efforts to combine into new varieties the desirable characteristics of both. Nearly 700 selections were made out of some 300 3rd and 4th generation progenies of such crosses.

In cooperation with the California Experiment Station, two new lines of crisp head lettuce have been increased and are now being tested on a commercial scale at several locations in the Imperial Valley.

Twenty-nine segregating lines representative of the several types of material in our California program were sent to the Lower Rio Grande Valley for study. Some of these lines should reveal the groups of progenies most likely to have potentialities for Texas. From such groups next season large numbers of segregating lines can be sent for selection.

Workers of the Vegetable Crops Section and of the Section of Soil and Water Management have initiated a study to determine the interactions of variety and soil fertility on yield and quality of lettuce grown variously for fall, winter, and spring harvest.

In the East - Crossing and selection were continued for resistance to tipburn, rib breakdown, heat, and rapid bolting and for high yield, eating quality and market qualities. Several new lines have resistance to both tipburn and rib breakdown will be increased on a small scale to get seed for general trial.

A new deep red leaf lettuce was entered in All America Selections because of its potential usefulness in prepack salad mixes in which red color is desired. Results of the AAS ratings are not yet received. If ratings justify it, the item will be released, first to seedsmen, then to the public.

A new very curly-leafed light green lettuce of the Grand Rapids type, desirable as a granish, will be entered in the 1955 AAS trials. It has attracted favorable comment of seedsmen and consumers alike.

After years of disappointment some of the hybrids between Lactuca sativa and L. virosa are beginning to show promise. A few show satisfactory commercial qualities as well as resistance to tipburn and rib breakdown. Attention to these will be stepped up in future trials.

Breeding for ability of lettuce seed to germinate at high temperature was continued. It is desired to include this characteristic in any new varieties developed.

Nearly 200 seed samples from a study of field crossing in the Imperial Valley were harvested in 1954 and are being grown for color determination in the greenhouse at Beltsville. The work is cooperative between the Eastern and Western members of the lettuce project.

Plans - Expansion of work into Texas was mentioned under comments on 1954 Recommendation. That work will continue. Incidental to moving a plant breeder from Beltsville, Md., to Salinas, Calif., the Beltsville activities on lettuce will be tapered off until all have been transferred to the field, probably about July 1, 1955. Other work in the West will continue along present lines with a small increase in resources.

Publications

The important diseases of lettuce. G. W. Bohn. U.S.D.A. Yearbook 1953, pgs. 417-425.

The striate-vein character in lettuce. Thomas W. Whitaker and G. W. Bohn. Jour. Hered. 44:177-180, 1953.

Shattering in lettuce - its inheritance and biological significance. Thomas W. Whitaker and G. D. McCollum. Bull. Torrey Bot. Club. 81:104-110, 1954.

Recent developments in California lettuce industry. J. E. Welch and Thomas W. Whitaker. Amer. Vegetable Grower. December, 1953, pgs. 6, 7 and 21.

Back crossing. The theory and practice of the backcross method in the breeding of some non-cereal crops. By Mary Thomas. A review. Thomas W. Whitaker. Jour. Hered. 44:245, 1953.

Review of the work of the Section of Vegetable Crops at the Southwestern Irrigation Field Station, Brawley, California. Imperial County Farm Bureau Monthly, May, 1954. Vol. 24, No. 5, pages 15, 26.

Report of the Annual meeting of the Southwestern Agricultural Scientific Research Committee of the Imperial Valley Farmers Association and the Staff of the Southwestern Irrigation Experiment Station, Brawley, California. Published in the Western Grower and Shipper under the title, "Row crop research projects planned." Vol. 25, No. 2 (January), 1954, pgs. 26, 27.

MUSKMELONS

Progress and Findings - 1954 Recommendation, "Initiate work on the breeding of disease resistant muskmelons for eastern-producing sections and expand the program of breeding for disease resistance for the western sections." (12/13)

A muskmelon breeding project is being added to the program of the Vegetable Breeding Laboratory at Charleston, S. C., and a plant breeder added to the staff there to handle the new work. The broad outlines of the work were developed at the last annual session of the cooperators of the Laboratory.

New cooperative arrangements have been recently completed for extending our work on muskmelons into Texas, initially in the Lower Rio Grande Valley. The Department, the Texas Experiment Station, growers and shippers and transportation agencies are involved. Resources contributed by industry and transportation agencies will aid in exploiting of breeding materials from the new project of the Vegetable Breeding Laboratory and from our old-established western project, alike.

In the West. In the long, wide-spread search for mosaic resistance in muskmelon, a form from China has been found that contains strains with some measure of resistance. Its marked difference from commercial types will necessitate a long program of breeding and selection to make effective use of its resistance. About 100 progenies of this material are in the 5th to 7th generation.

Late appearance of mosaic in the field and its mild intensity precluded evaluation of lines for resistance to mosaic in 1954. Evaluation of some 700 lines including cantaloup, Honey Dew, and Honey Ball types, however, was continued effectively with reference to resistance to powdery mildew and crown blight, and for vigor, yield, and commercial qualities.

Varietal studies showed Powdery Mildew Resistant No. 5 to be most resistant to crown blight of any of 15 commercial varieties tested but it was not the most vigorous grower. None of the most vigorous rated better than "good" on crown blight resistance, and most varieties that were rated as vigorous were very susceptible to crown blight, including PMR No. 6 and PMR No. 45. Susceptibility to mildew generally seemed related to susceptibility to crown blight, and mildew occurrence tended to intensify damage from crown blight.

A study was recently started on the effects of inbreeding and cross-breeding upon plant vigor, crown blight resistance, fruit size, and net development.

Studies were continued on inheritance of resistance to race 2 of powdery mildew. Of 8 lines resistant to this race, recent evidence indicates that the genes responsible for resistance are not the same in all lines. Definite knowledge of the factors controlling resistance should improve the efficiency of breeding operations and reduce costs of maintaining the reservoir of genes for resistance.

In cooperation with the California Experiment Station, 4 new powdery mildew-resistant Honey Balls were mass increased to obtain seed for commercial field trials at Brawley in 1955. New crosses were also made among 23 resistant inbreds to obtain better commercial properties without loss of resistance.

In the South. A start has been made in collecting breeding materials at the Charleston laboratory including Cucumis melo var. Chito, which carries mildew resistance. Crosses have been made with Smith's Perfect and a natural cross with a Hale Best type is on hand.

Plans - Work will continue in the Southwest essentially as at present but on a modestly increased scale. In the South and Southeast new work will be conducted to develop varieties suited to those regions and which are resistant to downy mildew as well as powdery mildew, and other diseases. (See comments following 1954 Recommendations above.)

Publications

A cross between an annual species and a perennial species of Cucurbita. Thomas W. Whitaker. Madrono 12:214-217. 1954.

An acetocarmine technic for Cucurbita. P. T. McGoldrick, G. W. Bohn, and Thomas W. Whitaker. Stain Technol. 29:127-130. 1954.

Growing cantaloupes in the Southwest. Thomas W. Whitaker and G. W. Bohn. Amer. Veg. Grower 2 (9):6, 7, 17. 1954.

Cucumbers, melons, squash. John T. Middleton, G. W. Bohn. U.S.D.A. Yearbook Plant Diseases. 1953:483-493.

Mosaic reaction and geographic origin of accessions of Cucumis Melo L. Thomas W. Whitaker and G. W. Bohn. Phytopathology. In Press.

Breeding for resistance to cantaloupe mosaic. Thomas W. Whitaker. Western Grow. and Ship. 25 (4):24, 26. 1954.

Muskmelon crown blight symptoms. G. W. Bohn. In mimeographed, "Report of Crown Blight of Cantaloupe Conference." Mesa, Arizona. Dec. 15, 1953. Pgs. 1 and 2.

Summary of observations of the crown blight of cantaloupes. Thomas W. Whitaker. In Mimeographed "Report of Crown Blight of Cantaloupe Conference." Mesa, Arizona. Dec. 15, 1953. Pgs. 3 and 4.

Lettuce, muskmelons, onions. Thomas W. Whitaker, G. W. Bohn, et al. Southwestern Irrigation Field Station Research Program 1954-1955:5-10. Mimeo. Pamphlet.

ONIONS

Progress and Findings - In the South - Another white Bermuda type onion called Eclipse was released to growers in the summer of 1954 by the United States Department of Agriculture and the Texas Agricultural Experiment Station cooperating. This new variety is somewhat higher yielding than L 365, which was released in 1953. Like L 365, Eclipse is highly pink-root-resistant. At Laredo, Texas, in heavily infested pink-root soil Eclipse produced 622 50 lb. bags of U.S. No. 1 onions per acre and only 3 bags of culls. A susceptible variety, Texas Early Grano 951, in the same soil produced 32 50 lb. bags of U.S. No. 1 bulbs and 163 bags of culls. About 15,000 pounds of Eclipse seed was available for planting in the fall of 1954.

In the North - In last year's report 12 hybrids were listed for introduction. Foundation seed for these hybrids was forwarded to seedsmen who requested it in January 1954. Practically all of the large onion seed producers requested seed, and they are now in the process of producing these hybrids. Small commercial plantings of the different hybrids were made in 1954 in important onion districts.

Field days were held in Idaho, Michigan, and Wisconsin. When growers and shippers were asked to evaluate the onions in the trials in no single instance did they rate the old commercial varieties over the hybrids. The results were so outstanding that the growers asked only when seed would be available. Some seed of certain items will be available in 1955, but it will be 3 or 4 years before the supply of seed of the new hybrids will equal the demand.

Plans - Work will continue on essentially the present scale. The chief problems at present are to incorporate disease resistance into the hybrids and to develop methods of handling so that parental lines of the various hybrids will coincide in their flowering period.

Publications

Rapid identification of recessive-white onion bulbs by use of ammonia fumes. Elmo Davis. Jour. Hered. 45:122. 1954.

Fiesta: a new hybrid onion for use where Sweet Spanish strains are adapted. D. F. Franklin, Henry A. Jones, and Clinton E. Peterson. Idaho Agr. Expt. Sta. Bull. 211. 1954.

Bonanza: a new hybrid onion for long storage. H. A. Jones, D. F. Franklin, and C. E. Peterson. Idaho Agr. Expt. Sta. Bull. 212. 1954.

The National Onion-Breeding Program, 1953. Henry A. Jones and others. Ninth annual report to cooperators. Multigraphed, 140 pp. 1954.

Abundance: a new high-yielding storage-type hybrid onion. H. A. Jones, C. E. Peterson, and D. F. Franklin. Iowa Agr. Expt. Sta. Special Report No. 6, May 1954.

Get ready for the Eclipse. Henry A. Jones and Bruce A. Perry. Southern Seedsman, September 1954.

Receptivity in the onion flower Allium cepa L. and some factors affecting its duration. Robert H. Moll. Proc. Amer. Soc. Hort. Sci. (In Press).

SPINACH

Progress and Findings - Work is being continued on the development of disease-resistant spinach varieties and hybrids. About 25 lines of spinach have been developed that are immune from blue mold (downy mildew). These are being used in hybrid combinations to determine their value for canning, freezing, and shipping. Most of the tests have been made in Arkansas and Texas. A number of these hybrids are very good, especially for canning and freezing. The most promising is

a selection 99 x 95 in combination with Virginia Savoy. The 99 x 95 selection is still heterozygous for blue mold resistance, about 7 percent of the plants being susceptible. Nevertheless, the growers have requested that this hybrid be made available. Consequently, the (99 x 95) x Virginia Savoy hybrid is being increased for planting in the fall of 1955. With average success there should be about 8,000 to 10,000 pounds of this hybrid seed available for planting by September 1955. It will probably take another 2 years to get blue mold immunity into this line, and into commercial production. However, immune lines now available may prove outstanding either by themselves or in combination. It appears that in a few years blue-mold-resistant spinach hybrids will take over, and our present commercial varieties will become obsolete.

A number of selections have been obtained that appear to be resistant to white rust. Large-scale tests at Parma, Idaho, indicate that some types of spinach are somewhat tolerant to curly top. Resistance to white rust and resistance to curly top will be incorporated into commercial types if possible but indications are that this will be a rather slow process.

SWEET CORN

Progress and Findings - 1954 Recommendation, "Expand breeding and disease research on vegetable crops to include --- present breeding programs on lettuce, sweet corn, and cabbage. (5/13)

The sweet corn breeding program in the South is being stepped up primarily through employment of additional subprofessional workers and increased support of field and laboratory work.

Work continues on the classification of inbreds with reference to resistance to ear worm, when selfed and when crossed with the testers Wappoo and Kiawah. Neither extreme of resistance or susceptibility has occurred. Based on the above three sources of material 8 possible groups of inbreds are emerging. No inbred has yet been found that assures resistance to its progeny in all crosses. Those resistant inbreds, however, that transmit resistance in crosses with both the above testers are considered as having dominant genes for these combinations. Generally, resistance and susceptibility appear to result from a complementary action of the genes contributed by each parent. One inbred has resistant progeny in most but not all combinations with inbreds tried.

Hereditary differences in rate and level of development of dry matter; and level and retention of sugar with development of maturity are being studied. Three lines have been developed that are outstanding for sugar content.

Varieties and breeding lines have been studied for possible differences in retention of sugar during the quick-freezing process and during storage thereafter. Within the limits of the material used so far, sugar loss during freezing is chiefly a function of the amount present before freezing regardless of variety. Percent sugar after freezing equals 2.2 percent \times (0.85 \times percent sugar before freezing). No appreciable change in sugar content occurred in 10 months storage.

Plans - Work will continue along present lines on a modestly expanded basis as indicated above.

Publications

Cytogenetics of the vegetable crops. I. Monocotyledons. S. H. Yarnell. Botanical Reviews 20:277-359. 1954.

SWEETPOTATOES

Progress and Findings - At Beltsville, Md., further crossing and seed production of sweetpotatoes was suspended temporarily in order to concentrate on the evaluation of nearly 200 clones and many seed lots collected in the Caribbean area by the Plant Introduction Section. Evaluation of seedlings on hand was continued. Production of seed of selected parents was continued at Meridian, Miss., Tifton and Experiment, Ga., and Baton Rouge, La., and evaluation of seedlings was continued at those three places.

The Caribbean collection has been distributed to several cooperators each of whom is evaluating the clones and seedlings for one or more characters including resistance to wilt, black rot, internal cork, soil rot, nematodes, and weevil.

The genetic studies of wilt resistance were continued at four locations. One hundred fifty seedlings of 3 backcross progenies were evaluated. The mode of inheritance is not yet evident.

Scores of new seedlings were grown in replicated trials by the cooperating group for choice of a limited number for a new set of regional trials beginning in 1955. Clones chosen for these trials will be given cooking and canning tests as part of the evaluation routine.

Roots of 4 new clones showed tolerance to black rot in storage tests, and a few showed plant tolerance when inoculated and planted in greenhouse beds. Disease resistance tests of all breeding materials is emphasized.

Plans - With the disease testing of the Caribbean collection largely in hand, crossing of selected parents and evaluation of progeny will be resumed at Beltsville and continued at other locations. The addition of a pathologist to the staff at Beltsville will increase the scale of disease testing possible.

Publications

Cooperative regional comparisons of 49 sweetpotato selections. C. E. Steinbauer et al (Processed joint report for cooperating group).

Sweetpotato cooperators conference. Dallas, Texas. 1954. C. E. Steinbauer (Processed report for cooperating group).

TOMATOES

Progress and Findings - In the South - Interest in the recently introduced Homestead variety continues to increase in southern Florida and is spreading to Texas and to the East Central States. A selection of Homestead having more uniformity and equal productivity is attracting favorable comment.

Advanced breeding lines are under test in many locations in the South and in Algeria, Egypt, Burma, England and Honduras.

Special efforts are now being made to combine into single varieties resistance to several diseases. Heretofore, attempts at highly multiple resistance have resulted in poor commercial properties although combined disease resistance was attained. Last season 38 F₁ and 30 F₂ populations involving some 45,000 plants in greenhouse tests and 24,000 plants in the field were evaluated. About 600 selections were made for further work.

In 1954 some 50 varieties averaged only two-thirds as much vitamin C content as in 1953: 17 mg/ 100 gm versus 24 mg/100 gm. Southland had the highest content of any variety tested.

In the East - A new highly wilt-resistant, highly productive red plum-shaped, paste tomato will be released to seedsmen for seed increase in 1955. It was developed from crosses involving Pan America, San Marzano, and Redtop. Single plants in the field have yielded up to 20 lbs. Seed for commercial tests in 1955 is being produced in Florida this winter. The variety probably will be released to the public for planting in 1956.

In breeding for resistance to tobacco mosaic 93 lines from crosses with L. hirsutum showing extremely mild or no symptoms following greenhouse tests, were grown in the field. Of these, 127 plants showing no symptoms at the end of the season, some of them with fruits up to 2 inches in diameter, were selected. About 70 other selections were made from F_2 and more advanced generations and backcrosses involving L. peruvianum. Progress in resistance to mosaic appears definite, but resistant commercial types are still a long way off.

Of 150 introductions screened for resistance to early blight, 2 lines from crosses involving L. pimpinellifolium were selected as resistant. Two others were also resistant and 8 were tolerant.

Sources of wilt resistance are no longer a problem. Our new commercial varieties are now generally more resistant to wilt than introductions received for screening.

In the West - Supposedly curly-top resistant lines when transplanted in California under conditions very favorable for curly top development made a poor showing. The same lines, however, when direct seeded and not thinned, in Idaho, showed 30 to 45 percent healthy plants at the end of the season while the VR Moscow control showed only 3 percent. It remains to be seen whether this degree of resistance is worth while from a practical standpoint.

Curly top tests on crosses with large-fruited verticillium resistant varieties are being conducted this winter with a view to field tests of progeny of any noteworthy survivors, in 1955.

Studies were continued with various inter-species crosses in efforts to develop higher degrees of curly top resistance. All efforts to cross tomato with curly top resistant species of Solanum failed.

Work was continued on the incorporation of Verticillium and Fusarium resistance into counterparts of the principal commercial varieties. Selections homozygous resistant for both diseases were field-tested for horticultural properties, but the season was too unfavorable to yield dependable information.

Genetic tests to determine the linkages of the gene for Verticillium resistance with other genes suggest that the resistance gene is on the same chromosome as the lutescent gene. Further tests are necessary to settle the point.

Plans - New cooperation has been arranged for extending tomato breeding work into Texas, initially in the Lower Rio Grande Valley. The Department, the Texas Experiment Station, growers and shippers, and transportation agencies are involved. Resources contributed by growers and shippers and by transportation agencies will aid substantially in the effective exploitation of breeding materials originated at the Charleston laboratory, at Beltsville, and elsewhere. The program at Charleston will be stepped up modestly through increase in subprofessional help and labor.

The scale of operations at Beltsville and Logan, Utah, will continue essentially as at present.

WATERMELONS

Progress and Findings - Breeding line No. 51-27 was introduced as Charleston Gray. It is a large, long, light green, black-seeded melon of high quality, high yield, resistance to anthracnose and wilt, and of better than average carrying quality. Preliminary trials developed an unprecedented (in our experience) enthusiasm for this variety. Because of large quantities of unauthorized seed produced, it is estimated that acreage in 1955--the first year after official release--may be as much as 50,000 acres.

Further work confirmed earlier indications that large-fruited, large-seeded melons are not suited for the production of seedless triploids of acceptable quality. Furthermore, response of watermelon varieties to colchicine treatment for doubling of chromosomes is erratic and generally unsatisfactory because of sterility. Studies will continue in a minor way to settle a few technical points but not with a view to developing large seedless melons.

Plans - With success realized in developing some good, large, long, disease-resistant varieties attention now is being shifted to doing the same with large and small round types. Scale of operations will remain essentially unchanged.

Publications

The Charleston Gray watermelon. C. F. Andrus. Seedsmens Digest. October 1954.

PESTS AND THEIR CONTROL

DISEASES - HC

Antibiotics

Progress and Findings - 1954 Recommendation, "Initiate a comprehensive study of natural and synthetic antibiotics or systemic fungicides and bacteriacides as control materials for plant diseases." (3/13)

New resources for fiscal 1955 will permit the establishment of a laboratory for screening large numbers of both synthetic and natural substances for their possible value as antibiotics for combatting plant diseases. By some temporary shifts in personnel it was possible to start promptly some basic studies on antibiotics in relation to virus diseases. Additional qualified personnel are being sought and facilities and equipment for the new work arranged.

A technique has been developed for rapidly and easily localizing virus inoculations and reading the results of virus multiplication, if any. The southern bean mosaic virus is being used initially to screen antibiotics for antiviral activity and to study the action of compounds having such activity.

A compound of Merck and Co., known as MK-61 or Noformicin and formerly reported to be an antiviral agent has been used in this preliminary work. Although it is not a good antiviral agent, it has been very useful in working out technique. When applied to a virus inoculated area immediately after inoculation it prevents movement by multiplication of the virus. Of 23 antibiotics tested thus far against the southern bean mosaic virus none have been effective. Seven other substances that have been reported to suppress multiplication of other viruses were also ineffective.

Plans - Work both on screening of substances and on the fundamental actions of antibiotics in plants upon viruses, bacteria, fungi, and nematodes will be conducted. In the new laboratory emphasis will be placed on basic facts and principles rather than developing details of large numbers of practical applications. If principles can be established, applications will follow rapidly by a multitude of workers dealing with various crops and problems in other units and agencies.

Current empirical work on antibiotic applications will continue essentially as at present.

Soil-borne diseases - 1954 Recommendation, "Initiate substantial research on the basic problem of controlling soil-borne diseases by biological means such as specific crop sequences, crop residues, manures, and cultural practices." (4/13)

Limited studies of an empirical nature have been continued on beans (see below), but without additional specific resources no overall basic project on this subject has been established. New work being planned on diseases of peanuts will stress the biological approach to the problem, but here again the large resources needed for adequate soil micro-population studies will not be available.

- B. Proposal for Committee Consideration - Initiate substantial research on the effects of cultural methods, soil management, crop sequences, use of crop residues, manures and green manures, and other production practices upon the micro-population of the soil and the inter-relations of these factors with the build-up or suppression of soil-borne diseases of crop plants.

Beans

Progress and Findings - In 1954 mild infection of beans with halo blight in the field was effectively eradicated with 3 sprayings of streptomycin at 250 ppm. More severe infection was cleaned up with 3 sprayings at 500 ppm. Severely infected plants may remain stunted after treatment with streptomycin but secondary spread of the organism is prevented because it is destroyed. Common blight is not controlled or eradicated by streptomycin.

In Florida 5 lbs. per acre of PCNB (pentachloronitrobenzene) gave encouraging results on partial control of Rhizoctonia and Pythium root rots of beans. It was most effective on sandy soil, least on muck soil.

In Michigan, of several combined fungicide-insecticide seed treatments Captan and dieldrin at 2 oz. per bushel gave best emergence. Ethyl B-856 was also satisfactory.

In Florida greenhouse tests the incorporation of nine kinds of dry crop residues into Rhizoctonia infected soil at 5 percent of the weight of the soil 5 days or more before planting significantly reduced the infection on the bean seedlings grown therein. Plantings at 10 and 15 days after application of the dry material were diseased progressively less. Additions of green organic matter did not reduce incidence of disease. Beans planted on freshly prepared beds containing preceding crop residues showed significantly more "root rot" than those planted 5 or more days after similar bed preparation. Other studies in Florida indicate soil-borne organisms such as Pythium significantly affect the incidence of bald head of beans in the field.

Rotation experiments for bean disease control in Idaho have been in progress 2 years, too short a time to yield significant results. On a field that had grown Pinto beans for 12 consecutive years 5 T per acre of manure produced one third more beans than the non-manured portions.

A rapid technique for testing snap beans for resistance to common bean mosaic was developed.

Plans - Work will continue essentially along present lines.

Publications

Absorption and translocation of streptomycin by bean plants and its effect on the halo blight and common blight organisms. J. W. Mitchell, W. J. Zaumeyer and W. H. Preston. Phytopath. 44:25-30. 1954.

Chemical soil treatments for the control of Rhizoctonia on snap beans. W. D. Moore and Robert A. Conover. (App. for publication in Plant Dis. Rptr).

Effects of antibiotics on health and growth of plants. H. R. Thomas. Soil Science Society of Florida Proceedings. 13: 17-25. 1953.

Factors affecting the development of necrosis in some bean varieties when inoculated with common bean mosaic virus. H. R. Thomas. Phytopath. (Abs.) 44: 508-, 1954.

A new suggestion for control of damping-off and root rot of snap beans. W. B. Tisdale and W. D. Moore. Fla. Agr. Expt. Sta. Cir. S-75 July, 1954.

Effect of downy mildew on lima bean seedlings resistant to the causal fungus. R. E. Wester. Proc. Amer. Soc. for Hort. Sci. Sept. 1954.

Farewell halo blight. Southern Seedsmen. W. J. Zaumeyer. Feb. 1954. pp. 26 and 80.

Beets for seed

Progress and Findings - Earlier reports were confirmed that (1) Virus yellows of seed beets reduces seed yields and that reduction is more severe when infection occurs in the steckling field than when it occurs only in the seed field. (2) Isolation of steckling fields from infected areas is a practical way to reduce damage substantially.

For the first time and contrary to earlier experience treatment of steckling fields with aphicides significantly reduced injury by virus yellows, compared with such fields not treated. It was further shown that continued steckling production in an originally "isolated" area will result in a slow build-up of virus yellows, the area tending to lose its value as an isolation area. Virus-free stecklings definitely may become infected when grown in a seed field in which infected stecklings are planted. Work will continue on control of the disease through use of aphicides in steckling fields in isolated areas for progressive numbers of years.

Results of these studies have induced beet seed growers of the Skagit Valley to grow all their stecklings in 1954 in isolated localities. Depending on the numbers of times specific "isolated" sites have been used consecutively, it is expected that virus yellows in the seed crop of 1955 will be the lowest in many years. With increasing use of isolation of steckling fields yellows was less severe in 1954 seed fields than any year since these studies were begun.

Plans - With the "isolation" angle satisfactorily settled, emphasis will now be increased on the detailed relationship of aphids and aphid control to virus yellows. Isolated areas may not long be kept sufficiently "isolated" and naturally relatively free of insect carriers of the virus. Possible loss of effectiveness of "isolated" areas must be guarded against.

Publications

Diseases of table beet seed plants in Western Washington. D. M. McLean and Leo Campbell. (To be published by Washington State College).

CABBAGE

Progress and Findings

Cabbage seed crops in the Northwest - The year 1954 was especially favorable for development of stalk rot or white blight. As in other years some reduction of infection was obtained with fungicides but not enough to result in higher yields of seed. Karathane, Ziram, HD-160, Puratized Agr. Spray and Captan were each applied 5 times to quadruplicate blocks. Puritized and Ziram reduced the number of infection centers about a third. None is yet worth recommending as practical control.

Very heavy autumn applications of calcium cyanamid were used in efforts to suppress or destroy sclerotia in the soil. Infection of plants was reduced, the plants were greener, but no increase in seed yield resulted. Further trials will be made.

Cucumbers and Muskmelons

Progress and Findings - Agrimycin, a commercial preparation of antibiotics for agricultural use was tried for control of angular leaf spot of cucumber. The Terramycin in Agrimycin (1.5 percent) appeared to have little or no effect on control but the streptomycin (15 percent) had marked effect. When Agrimycin (with the streptomycin concentration at 400 ppm) was applied 24 hours before heavy artificial inoculation, infection was but 10 percent of the controls; 200 ppm. was less effective. When 400 ppm. was applied 1, 2, or 3 days after inoculation, infection was reduced to a mere trace and many plants remained disease-free. In an excessively heavily inoculated series, 200 ppm. gave partial control about equal to that of Tribasic copper.

Tests of fungicide combinations for control of angular leaf spot and downy mildew were continued. A tank mixture of Tribasic copper (3 to 100) and Dithane Z-78 (2 to 100) was superior to Tribasic copper alone in controlling angular leaf spot, and to Z-78 alone for downy mildew. The tank mixture was superior to alternating sprays of the two fungicides.

Tribasic copper (4 to 100) alternated with Dithane Z-78 (2 to 100) was second best, and Tribasic copper-Zerlate tank mixture was third. Copper alternated with Zerlate, Fermate, or a mixture of Dithane Z-78 and Zerlate failed to control mildew.

For controlling downy mildew in muskmelons Tribasic copper alone (3 to 100) was less effective than in 1953. As with cucumbers, above, a tank mix of Tribasic copper (3 to 100) and Dithane Z-78 (2 to 100) was superior to all other mixtures tried. Tribasic copper (3 to 100) mixed with Zerlate (2 to 100) was good in 1953 but not superior in 1954. Various other mixtures and alternations of these materials were rather poor or ineffective.

Plans - Work will continue along lines reported here.

Publications

Report of results of 1953 spray tests. F. S. Beecher. In Results of 1953 Fungicide Tests. Agric. Chemicals 9(1): 73. 1954.

Sweetpotatoes

Progress and Findings - 1954 Recommendation, "Expand breeding and disease research on vegetable crops to include initiation of comprehensive study of internal cork and other virus diseases of sweetpotatoes----." (5/13)

A plant pathologist who is recognized for his extensive work on virus diseases of horticultural plants has been recently added to the staff and assigned the problem of internal cork of sweetpotatoes as his dominant responsibility. He is in process of arranging his research facilities and materials in preparation for a vigorous attack on the problem, both independently and in cooperation with others.

See section on breeding of sweetpotatoes for report of work on diseases as related to breeding.

In preliminary work on internal cork at Beltsville, some plants of supposedly cork-free stock of Porto Rico in 1953 exhibited ring-markings of leaves that are presumed by some to be symptoms of internal cork. Our workers have not been convinced that ring spot is a symptom of cork. Roots from 48 ring-marked plants were stored 60 days at 70° F., and minutely examined for cork without finding a trace. Plants from these same lots of roots, grown in the field in 1954 varied in ring-spotting, from none to 100 percent of the plants in a given lot. Roots from the 1954 plants are in storage for later examination for internal cork.

Greenhouse experiments indicate that cork-free plants may become infected by "corky" plants if the intermingled roots of the two classes of plants are injured by slashing through them with a tool. There was no evidence of transmission when the intermingled roots were not injured.

All efforts to transmit internal cork by leaf or root juice transfers to healthy sweetpotato or other plants have failed.

Plans - Internal cork studies will be greatly expanded this year, receiving practically full-time attention of a plant pathologist and subprofessional and other help. (See comment on 1954 recommendation, above). Incidental attention will be given to routine disease tests in breeding work.

Tomatoes and Peppers

Progress and Findings - In continued greenhouse studies of internal browning in tomato wide variations in nutrients in sand culture failed to produce symptoms. The strain of tobacco mosaic commonly isolated from internally browned fruits failed to induce symptoms upon inoculation. Occurrence in field tests was too low to give convincing results but inoculated plants on sandy soil produced a few affected fruits while those on heavy soil and on the non-inoculated checks produced no affected fruits. The partial role of the virus is still suspect, and is being followed up in greenhouse studies with variable moisture supply.

Tests to detect pepper seed transmission of tobacco mosaic, tobacco etch, ordinary cucumber mosaic, and two cucumber mosaic ring spot strains have all proved negative.

A virus was detected in pepper fruits showing simple pits in the surface without mottle or abnormal color. Parent plants appeared normal. The virus is under investigation.

Plans - Work will continue along present lines.

Plant beds in the South - Because of the extreme drought in southern Georgia no results on spring or summer fungicide studies on tomato plant were possible.

Fall fungicide tests on cabbage plants for mildew control were productive. Spergon, Kolophygon, and Parzate dusts were superior to Dithane Z-78 as dust or spray and to Spergon spray.

Emergence of pepper seed was not impaired by 500 ppm. of streptomycin as a seed-treatment. Five percent New Improved Ceresan reduced germination below that of bichloride of mercury (2 to 1000).

In cooperative tests, polyethylene film bags and liners for crates and baskets gave excellent results for the shipping of bare-rooted tomato plants. These materials indicate possibilities of considerable savings in packing and shipping costs, compared with conventional wet moss and heavy paper packing. This work will be continued.

Plans - Work will continue along present lines.

Publications

The use of wild Lycopersicon species for tomato disease control.
S. P. Doolittle. Phytopath. 44(8): 490-414. 1954.

Estimates of diseases losses in vegetable crops. S. P. Doolittle.
IN "Losses in Agriculture." pp. 37-51 (figures). ARS-20-1. 198 pp. 1954.

Results of cooperative testing of Lycopersicon species for resistance to tobacco mosaic virus. S. P. Doolittle. In a Regional Bulletin "Disease Resistance in the Wild Species of Tomato: Report of National Screening Committee." In Press.

Root-rotting fungi

Progress and Findings - Isolations of Aphanomyces cladogamous from pansy plants dying of severe root rot near Washington, D. C., were found capable of killing seedlings of tomato, pepper, eggplant, and spinach. It seems likely that A. cladogamous may be responsible for unusually severe losses in fields of young spinach that have now and then been observed during very wet seasons.

Cultures of the small Pythium designated as P. deliense and P. aphanidermatum were compared with cultures of the larger but closely related P. butleri. As the small Pythium does not occur at Beltsville it was submitted to another worker for identification. No inoculation trials are contemplated.

In collaboration with H. A. Borthwick and W. D. McClellan much time was devoted to careful examination of cultures of Pythium, Conidiobolus, and Basidiobolus grown under exposure to different kinds of light. Though fairly consistent effects were noted in some instances, these could not readily be correlated with radiation effects observable in higher plants.

Plans - Studies will continue on the present basis.

Publications

Two species of Conidiobolus with minutely ridged zygosporos. C. Drechsler. Amer. Jour. Bot. 41: 567-575. 1954.

Morphological features shown in Aphanomyces isolations from roots of spinach and flax. C. Drechsler. Jour. Washington Acad. Sci. 44: 212-219. 1954.

Aphanomyces euteiches from pea roots and Aphanomyces euteiches P. F. C. Drechsler. Wash. Acad. Sci. 44(8): 236-244. 1954.

Production of aerial arthrospores by Harsporium bysmatosporum. C. Drechsler. Bull. Torrey Bot. Club. 81: 411-413. 1954.

Mushrooms

Progress and Findings - Work is nearing completion on the feasibility of controlling soil-borne diseases of cultivated mushrooms by watering the beds with chlorinated water - 100 ppm. available chlorine. This procedure appears to offer a practical means of controlling two diseases which were formerly refractory: bacterial blotch and bacterial pit. It seems probable that chlorinated water will also control the verticillium disease and retard the mycogone disease. Yields are not adversely affected by chlorinated water.

Plans - Studies will be continued along the same lines.

Publications

Diseases of the Common Mushroom. Edmund B. Lambert and Theodore T. Ayers. Yearbook of Agriculture. 1953.

Plant Disease Warning Service

Progress and Findings - This activity has now become established in a smooth operating routine, effectively performing its function of forecasting dates to begin control measures for late blight of tomato and potato and downy mildew of cucurbits in specific districts. No new service was added during the year.

Plans - Continuation of service on present basis, pending some new development.

Publications

Progress in forecasting late blight of potato and tomato. R. A. Hyre. Plant Dis. Rptr. 38: 245-253. 1954.

The spread and increase of internal cork virus of sweetpotatoes in North Carolina. L. W. Nielsen and L. H. Person. Plant Dis. Rptr. 38: 326-328. 1954.

A dew recorder. J. R. Wallin and Dale N. Polhemus. Science 119: 294-295. 1954.

Forecasting potato late blight in North Dakota. J. R. Wallin and Wm. G. Hoyman. North Dakota Agr. Expt. Sta. Bimonthly Bull. Vol. 16: 226-231. July-August, 1954.

Studies of temperature and humidity at various levels in crop cover with special reference to plant disease development. J. R. Wallin and R. H. Shaw. Iowa State College Jour. Sci. 28: 261-267. 1953.

INSECTS - ENT

Progress and Findings - 1954 Recommendation "Expand research on the control of vegetable insects to provide for more attention to those attacking sweet corn and to develop methods for controlling important vegetable pests not now receiving attention." (8/13)

Some work on these problems was possible by using resources made available by the completion or restriction of other work, as indicated by the report given in the following paragraphs dealing with those crops.

Sweet Corn

Corn earworm infestation in sweet corn plots in Texas was very heavy, permitting an excellent appraisal of the strains for resistance to corn earworm attack. Some of the strains were sufficiently resistant to be free of infestation when the corn was harvested. The silks on one experimental inbred are lethal to young earworm larvae hatching on them and as a result, all ears of this strain were free of live larvae at harvesttime. Another inbred also has a lethal factor in the silks, but it is less pronounced. Five among 81 selections of sweet corn inbreds that showed promising resistance to the corn earworm were also highly resistant to the European corn borer. The development of a satisfactory sweet corn resistant to both the corn borer and earworm would be of outstanding benefit to the market grower and canner.

Insecticide and resistance tests aimed toward better control of the corn earworm were continued in southern Texas, and similar work was initiated in south central Florida. Some attention was also given the problem of corn earworm control in Washington where over 20,000 acres of sweet corn grown for canning and freezing were severely infested by that pest.

Plans - These investigations will be continued, in cooperation with the State agricultural experiment stations and Federal sweet corn breeders.

Proposals for Committee Consideration - See page 39.

Publications - Distribution of the European corn borer parasite Perezia pyraustae, and its effect on the host. H. L. Zimmack, K. D. Arbuthnot, and T. A. Brindley. Jour. Econ. Ent. 47 (4): 641-645. 1954.

Status of the European corn borer in 1953. R. L. Shotwell, USDA Cooperative Economic Insect Report. 4 (6): 105-126. Feb. 12, 1954.

Cole Crops

Progress and Findings - In field experiments for the control of the cabbage aphid on cabbage in South Carolina demeton (Systox), TEPP, parathion, and methyl parathion dusts were the most effective insecticides. Single applications of demeton and of TEPP, just before the plants began heading, reduced the proportion of heavily-infested plants to 1 percent or less. Two applications of parathion gave similar results. Malathion and nicotine sulfate proved less effective.

Endrin dusts at approximately 0.25 lb. per acre-application gave outstanding protection to spring-crop cabbage against the cabbage looper, imported cabbageworm, and larvae of the diamondback moth and to young fall-crop cabbage against the cabbage webworm, corn earworm, and fall armyworm in South Carolina. Toxaphene and Strobane dusts gave good control of the cabbage webworm and fall armyworm. Toxaphene ranked second to endrin in effectiveness against the cabbage looper and imported cabbageworm. Parathion showed a relatively high degree of toxicity to the imported cabbageworm and diamondback moth, but was only moderately effective against the cabbage looper. Malathion was slightly less effective than parathion against the looper. Cryolite, dieldrin, and compound Q-137 (Perthane) gave moderate control of some species of cabbage pests but not of others. The cabbage looper continued to show an apparently increasing degree of resistance to DDT and there were some indications of resistance by the imported cabbageworm. In experiments in California, endrin, Strobane and dieldrin dusts gave satisfactory control of serious cabbage looper infestations on turnips.

A survey of 83 insecticide-treated cabbage fields in California indicated that the parasite Diaretus rapae was the most important natural enemy of the cabbage aphid during the spring. This parasite was not adversely affected by 3 or 4 applications of DDT or parathion followed by one application of TEPP. Eight to ten treatments of these insecticides caused a marked decrease of the parasites. BHC

was very toxic to the parasite. All of the insecticides tested caused a marked reduction of aphid predators. The parasite D. rapae was also abundant in cabbage aphid-infested fields of South Carolina and proved of considerable value in keeping the pest in check.

Under laboratory conditions a polyhedrosis virus gave promise of being effective against the cabbage looper. Field tests are under way to determine the effectiveness of this organism against the looper on cabbage in South Carolina and on cabbage and broccoli in California.

Plans - Work will be continued to develop more effective insecticides for cabbage aphid control and to determine an acceptable substitute for DDT in localities where this insecticide has shown decreased effectiveness against caterpillars on cole crops. Research on natural enemies of insects affecting cole crops will be continued and emphasis will be placed on further studies of diseases for control of the cabbage looper.

Proposals for Committee Consideration - See page 39.

Publications:

Insects and their control. D. J. Caffrey and R. C. Thompson. For inclusion in Farmers' Bulletin 1957 on cauliflower and broccoli varieties and culture. August 1954.

Tests with DDT and other insecticides for control of the cabbage looper in Southern California. J. Wilcox and A. F. Howland. Jour. Econ. Ent., Vol. 47, No. 5, pp. 932-938, Oct. 1954.

Beans

Progress and Findings - Dusts containing 4 percent malathion or a mixture of 3 percent malathion and 3 percent methoxychlor gave excellent control of the Mexican bean beetle in experiments in Virginia and North Carolina. The latter mixture was the most effective of the materials tested against the potato leafhopper on beans. Dust mixtures containing 1 percent rotenone were among the most effective against the Mexican bean beetle at Norfolk, Va., but were decidedly inferior when used in the Mills River, N. C. area. Laboratory tests, using field-collected larvae from Norfolk and from Mills River, indicated clearly that the cause of this difference in effectiveness is due to a resistance to rotenone in the Mills River beetles. Further tests demonstrated that the resistance to rotenone by the western North Carolina strain of beetles was apparently passed on to at least one, and probably two, succeeding generations without diminution.

One treatment of the systemic insecticides, demeton, methyl systox, or schradan gave satisfactory control of the two-spotted spider mite on lima beans in California for a period up to 36 days. An Aramite-sulfur dust, a parathion spray (2 applications 1 week apart), FW-293 (Rohm & Haas) 10 percent dust, and Aramite 3 percent dust were effective against this mite. Demeton, FW-152, FW-293, and Aramite were effective against associated infestations of the two-spotted spider mite and the red spider mite on lima beans. A difference in effectiveness of miticides against different species of spider mites on the same crop makes the control problem very difficult.

Studies in California showed that dusts containing DDT, heptachlor, aldrin, isodrin, endrin, dieldrin, chlordane, Diazinon, toxaphene and parathion were effective, but not superior to DDT, in controlling a light infestation of lygus bugs on lima beans. One application of the insecticides just after the lima bean plants began to bloom was more effective against the lygus bugs than applications made 2 or 4 weeks later. All of the insecticides in these tests were toxic to the natural enemies of the lygus bugs, consisting principally of lady beetles, predaceous bugs, lacewings and spiders.

Experiments for the control of the western bean cutworm were conducted in six bean fields near Rupert, Idaho. Dusts containing DDT, toxaphene, dieldrin, aldrin, endrin and a DDT-sulfur mixture were applied by aircraft in five fields and by ground equipment in one field. Results were not available when this report was prepared.

Laboratory tests with 30 insecticidal dusts against the beet leafhopper as a pest of garden beans grown for seed in southern Idaho showed DDT (90° C. setting point); DDT in a micronized form; CS-645A; and CS-674A (Commercial Solvents Co. products) worthy of further testing under field conditions. The hormone 2, 4-D gave negative results against the beet leafhopper when used as a seed soak or as a spray on young bean plants.

Nearly 120,000 egg parasites of the beet leafhopper, consisting of three species, were bred from material originating in Europe and released in leafhopper-infested districts of California, Arizona, Utah and Idaho. Approximately 55,000 of these were released in the last three states listed. This work was carried on in cooperation with the California Agricultural Experiment Station.

Preliminary laboratory and field tests were conducted in Virginia on the use of the entomophagous fungus disease Metarrhizium anisoplae against the Mexican bean beetle adults, eggs and larvae. It was shown that this disease is virulent against the three stages of the insect but final results were inconclusive because of unfavorable weather conditions.

Large-scale field experiments in Idaho to control the seed-corn maggot as a pest of field beans (Great Northern and Red Mexican) using aldrin, dieldrin, lindane, chlordane, heptachlor, DDT, toxaphene, isodrin, and malathion in slurry seed treatments in combination with the fungicide thiram, and a methyl cellulose sticker, gave inconclusive results, owing to a relatively low population of the insect. Some of the insecticides, particularly chlordane, toxaphene, lindane, aldrin, dieldrin and isodrin had an injurious effect upon the germination of the bean seed. Additional work is needed to determine the most effective dosages for the control of the maggot and which will avoid seed injury, under Idaho conditions.

Preliminary field experiments indicated that DDT or endrin dusts were effective against corn earworm attacking lima beans in California and that endrin was effective for the control of the lima bean pod borer. Three applications of either of these insecticides at 2-week intervals more than doubled the production of green lima beans.

Plans - Insecticides will be tested further to develop better means for controlling the Mexican bean beetle, potato leafhopper on beans, spider mites, lygus bugs, western bean cutworm, beet leafhopper, seed-corn maggot, corn earworm and lima bean pod borer. Research on the possibility of utilizing parasites and diseases of bean pests will also be continued.

Proposals for Committee Consideration - See page 39.

Publications

Snapbeans for marketing, canning, and freezing. Anonymous. F. B. 1915, Sept. 1954.

Beet leafhopper control experiments on snap beans grown for seed. Deen, O. T. and H. C. Hallock. J. E. E., Vol. 47, No. 1, pp. 122-126. Feb. 1954.

The beet leafhopper. Douglass, J. R. and W. C. Cook. USDA Cir. 942, June 1954.

The seed corn maggot on beans - how to control it., Elmore, John C. USDA Leaflet #370. Sept. 1954.

Wireworms and their control on irrigated lands. Lane, M. C. and M. W. Stone, F. B. 1866, USDA (Rev.) April 1954.

Treatment of bean seed for the seed-corn maggot. J. C. Elmore. Jour. Econ. Ent. Vol. 46, No. 6, pp. 1054-1059. Dec. 1953. (issued 1954)

Field experiments with insecticides for the control of wireworms in irrigated lands. M. W. Stone and F. B. Foley. Jour. Econ. Ent. Vol. 46, No. 6, pp. 1075-1083. Dec. 1953 (issued 1954).

Sugar-beet wireworm predaceous on seed-corn maggot. M. W. Stone, Jour. Econ. Ent. Vol. 46, No. 6, p. 1100. Dec. 1953 (issued 1954).

Comparison of demeton dusts and sprays on beans and strawberries. J. Wilcox and A. F. Howland. Jour. Econ. Ent. Vol. 47, No. 5, pp. 945-946. Oct. 1954.

Cucurbits

Progress and Findings - An experienced taste panel of HN (Human Nutrition Research Branch) reported (in March 1954) that no significant difference in flavor was found between untreated yellow summer squash and that given weekly applications of lindane until the day of harvest in the 1953 fall-season tests in South Carolina for the control of the pickleworm. Lindane continued to provide adequate protection to fall-season squash and cucumbers against the pickleworm and all associated insects except leaf miners. Parathion gave excellent control of the leaf miners and adequate protection against the other insects present. Endrin also was effective against the pickleworm, but gave only fair control of leaf miners. Endrin was effective and superior to lindane against the squash vine borer during further studies designed to develop a satisfactory procedure for controlling that insect on summer squash.

Continued investigations on the beet leafhopper as a pest of cantaloups in Arizona showed that the weed-host plants of this insect occurring in cantaloup fields have an important role in developing high populations of the beet leafhopper with a resulting increase of curly-top disease transmitted to the cantaloups. Beet leafhopper populations and curly top in the cantaloup fields of the Salt River Valley of Arizona were lower in 1954 than during the preceding two years, a condition which was reflected in an increased yield of cantaloups. Experiments in this Valley during 1954 showed endrin spray or parathion dusts to be effective against dipterous leaf miners infesting cantaloups. Dieldrin dusts or sprays shown in experimental work of previous years to be effective against these insects, were ineffective in the 1954 experiments.

Plans - The search will be continued for more satisfactory insecticides to control the principal pests affecting cucurbits such as the pickleworm, melonworm, squash vine borer, leafhoppers, spider mites and leaf miners, with special reference to materials which will not incur a health hazard nor cause off-flavors in the market product, nor leave residues in the soil which will adversely affect the yield and quality of subsequent crops.

Proposals for Committee Consideration - See page 39.

Publications

The beet leafhopper. Douglass, J. R. and W. C. Cook, USDA Circ. 942. June 1954.

Effect of curly top-infective beet leafhoppers on cantaloup plants in varying stages of development. Hills, Orin A. and Edgar A. Taylor. J. E. E., Vol. 47, No. 1, pp. 44-48. Feb. 1954.

Tomatoes

Progress and Findings - Experiments in California showed excellent control of the tomato fruitworm with dusts containing DDT alone or DDT combined with sulfur, parathion or endrin. Dusts containing endrin, toxaphene, dieldrin, or isodrin were less effective. Because of low infestations, scheduled insecticide experiments against this insect in Utah were cancelled.

In experiments in Utah for the control of the beet leafhopper and curly top on tomatoes, three applications of a DDT emulsion spray or of a DDT-sulfur dust at approximately 10 day intervals reduced the curly top-infected tomato plants by approximately 45 percent.

Experiments for the control of dipterous leaf miners affecting tomatoes in California gave negative results due to the low infestation of these insects.

Plans - Experiments for the control of the beet leafhopper as a pest of tomatoes and on the tomato fruitworm, leaf miners and associated pests on this crop will be continued insofar as available resources permit.

Proposals for committee consideration - See page 39.

Publications -

The beet leafhopper. Douglass, J. R. and W. C. Cook, USDA Circ. 942. June 1954

Residues of malathion on greenhouse lettuce and tomatoes and on green onions. Smith, Floyd F. et al. J. E. E., Vol. 47, No. 1. pp. 183-186. Feb. 1954.

The tomato fruitworm - how to control it. Wilcox, J. and A. F. Howland, USDA Leaflet No. 367. July 1954.

The tomato russet mite. Wilcox, J. and A. F. Howland. E Circular E-876. April 1954.

Onions

Progress and Findings - Experiments in Idaho for the control of the onion maggot showed that higher yields of seed were obtained when the onion bulbs were soaked before planting in emulsions containing chlordane or heptachlor. Chlordane gave a 62-percent increase and heptachlor a 45-percent increase in seed production when the bulbs were immersed for only 5 seconds. When onion bulbs were planted in furrows to which wettable powders of aldrin or chlordane had been applied, at the rate of 2 pounds of the active ingredient per acre, the seed yields were increased 62 and 48 percent respectively for the aldrin and chlordane. Aldrin, dieldrin and heptachlor in slurry treatments of onion seed, in combination with the fungicide thiram and a methyl cellulose sticker, gave inconclusive results because of a low maggot infestation.

Plans - Insecticide tests will be continued against the onion maggot with the objective of developing more effective control methods.

Proposals for Committee Consideration - See page 39.

Publications

Residues of malathion on greenhouse lettuce and tomatoes and on green onions. Floyd F. Smith et al. J. E. E., Vol. 47, No. 1, pp. 183-186. Feb. 1954.

The onion thrips - how to control it. Wilcox, J. and F. H. Shirck, USDA Leaflet No. 372. Sept. 1954.

Green Peas

Progress and Findings - Investigations in Washington and Oregon showed that chlorthion at the rate of 4 ounces of active material per acre is fully as effective against the pea aphid as parathion at 6 ounces per acre, or malathion at 16 to 18 ounces per acre. No data are available regarding residues resulting from the use of this insecticide, so chlorthion is not yet ready to be recommended. Seed treatments showed that demeton and one of 3 other systemic materials gave some protection against aphids for about a month after the seed was planted. They did not give protection against the virus diseases carried by the pea aphid, which are apparently transmitted before the insect can be killed by the insecticide. Foliage treatments with demeton showed that peas were protected against aphid infestation for about 2 weeks after spraying. After 2 weeks, the lower (sprayed) leaves showed about 8 parts per million of demeton, and the new, unsprayed tips about 1 part per million. This would indicate a very limited translocation upward. Three weeks after spraying neither the pods or the shelled peas showed any detectable residues of demeton. Sprays of malathion were applied to randomized blocks of 4 varieties of peas, at 3 different times, in the attempt to find out whether aphids are controlled at one stage of growth more effectively than at other stages. The peas did not grow normally and evenly because of uneven germination and severe virus conditions. The first spray, applied in the early bloom stages of Thomas Laxton and Perfected Freezer peas, increased the yields of these varieties over the corresponding checks, and over the other spray treatments, which were applied one and two weeks later. None of these sprays affected the yield of either Perfection or Perfected Wales, as compared to their checks. The experiment is preliminary, and the problem needs further study.

In Washington, 13 varieties and strains of peas were tested for their ability to maintain pea aphid populations. Ten of these were strains of Thomas Laxton. Of these, strain #78 from Associated Seed Growers, maintained its superiority over the others by producing the lowest aphid populations. This is the third year that this strain has been definitely superior to others tested against it. This strain is definitely more difficult for the aphids to infest successfully, as shown by the number of uninfested plants, and the colonies also grow more slowly than on most other varieties and strains tested.

With the concurrence of the Idaho Agricultural Experiment Station the pea weevil research at Moscow, Idaho, was terminated on May 31, 1954. Any further studies needed on this insect will be carried on by the field station at Walla Walla, Washington.

Plans - Research will be continued to develop more satisfactory insecticides for pea aphid control with special reference to materials which will not incur hazards to the consumer or to the operator and which will not affect the yield or quality of the crop adversely. Research will be continued on the ecology of the pea aphid, including studies on the relative susceptibility of standard and special varieties or strains of peas to pea aphid attack and damage.

Proposals for Committee Consideration - See page 39.

Publications

How to control the pea weevil in the home garden. Ralph Schopp. Idaho Agricultural Science, Vol. 34, No. 1, page 6. April 1954.

Lettuce

Progress and Findings - Field experiments in the Salt River Valley of Arizona indicated that dusts containing toxaphene or endrin were effective against the cabbage looper on lettuce. Dusts containing parathion, malathion, DDT, or TDE were less effective. The addition of DDT to toxaphene dust did not increase its effectiveness against the looper. Field experiments have been started in Arizona to determine the effectiveness of a polyhedrosis virus against the cabbage looper on lettuce.

Field-plot experiments showed that malathion or endrin dusts gave fair control of the lettuce aphid while dusts containing DDT, toxaphene, or dieldrin were relatively ineffective. Laboratory tests of various insecticidal dusts against this insect indicated that malathion, chlorthion, Diazinon, or parathion were more effective than either endrin, Strobane or Perthane.

Field-plot experiments indicated that DDT dust was effective against the corn earworm on lettuce and would give adequate protection if used with proper timing. Tests on single plants showed that insecticide dusts are not effective after the larvae of the corn earworm has entered the lettuce heads. In these tests the number of wormy heads was reduced by DDT or toxaphene dusts whereas dusts containing parathion, malathion, heptachlor, demeton or cryolite were less effective.

Plans - Work will be continued to develop more effective methods for the control of the cabbage looper, aphids, corn earworm and associated insects affecting lettuce. Research on the possibilities of utilizing disease organisms to control insects on lettuce will be continued.

Proposals for Committee Consideration - See page 39.

Publications

Residues of malathion on greenhouse lettuce and tomatoes and on green onions. Smith, Floyd F. et al. J. E. E., Vol. 47, No. 1, pp. 183-186. Feb. 1954.

Sweetpotato

Progress and Findings - On the basis of results obtained during 1953 dieldrin dust was recommended and widely adopted by growers for the control of the sweetpotato weevil in plant beds in the infested area of Louisiana during 1954 (In cooperation with the Plant Pest Control Branch and the Louisiana Department of Agriculture and Immigration). Three or 4 applications of a 2-percent dieldrin dust (non-granular) are recommended at the rate of 25 pounds per acre, per application, on and around the base of the plants in the beds. The first application is made just after the first few plants show color in the stems; the second application after all the plants are up; the third after the first pulling of the plants and the fourth at the time the stems drop to the soil surface. Experiments were undertaken in 1954 to determine the effectiveness of dieldrin against the sweetpotato weevil when applied on the soil surface around the base of the growing plants in the field, but the results were not available when this report was prepared.

Plans - Research will be continued to develop satisfactory insecticides for the control of the sweetpotato weevil in the field with special reference to materials which will not incur hazards to the consumer or to the operator and which will not affect the yield or quality of the crop adversely.

Proposals for Committee Consideration - See page 39.

Publications

The sweetpotato weevil and how to control it. Anonymous. Leaflet 121, USDA. Jan. 1954.

The biology of the sweetpotato weevil. Deen, O. T. (Cockerham, K. L. et al) La. Tech. Bul. No. 483. Jan. 1954.

Toxicity of various fumigants to sweetpotato weevils and their effect on sweetpotatoes. C. H. Gaddis. Jour. Econ. Ent. Vol. 46, No. 6, p. 1113-1114. Dec. 1953. (issued 1954)

Vegetables (General)

Progress and Findings - Research in Washington and California gave additional information regarding the minimum effective dosages of several insecticides for the control of wireworms affecting various vegetables on irrigated lands. Heptachlor, mixed in the soil at rates of 2 or 4 pounds per acre, was as effective against wireworms as DDT at a rate of 10 pounds per acre. Aldrin, dieldrin, chlordane, endrin and isodrin were all toxic to wireworms but do not seem to be as promising as DDT or heptachlor for wireworm control. Diazinon and Perthane were ineffective against these pests. None of these insecticides caused injury to vegetables growing in treated soils or adversely affected yields.

Bioassay tests showed that DDT remained toxic to newly hatched and very young wireworms for a period of at least 8 years. DDT is still considered to be the best insecticide for wireworm control in the irrigated lands of the Pacific Northwest.

A study was made in Washington on the relative toxicity of aldrin, dieldrin, heptachlor, and DDT on various ages of wireworms. Aldrin or dieldrin, at 3-pounds per acre, were more effective in killing 3-year old wireworms than either DDT at 20-pounds per acre or heptachlor at 3 or 6 pounds. All were equally effective, however, in killing newly hatched or 1-year old wireworms.

Research was conducted in Washington to find insecticides suitable for use as seed treatments to prevent wireworm damage in the early growth stages of vegetables. Lindane gave the best results in preventing injury from wireworms but had a tendency to retard germination and has a history of causing off-flavor to some vegetables grown in treated soils. Heptachlor showed some promise as a seed treatment.

In California, heptachlor, aldrin, and DDT applied to soil in March 1952 were still effective against wireworms in June 1954. Endrin, dieldrin, and chlordane were effective during the first and second seasons, but were not very effective by the third season. When applied to the soil in February 1954, heptachlor, dieldrin, aldrin, and DDT did not give adequate wireworm control within 36 days but were effective in 63 days. Lack of effectiveness early in the season was probably due to low soil temperatures, as the same materials, except DDT, applied in April gave nearly 100 percent control in 21 days. Soil applications of endrin, dieldrin, and heptachlor in April 1954 protected sweetpotatoes from wireworms more effectively than DDT, isodrin, toxaphene, or aldrin.

Surveys indicated that the wireworm Conoderus vagus Cand., a native of South America not recognized until 1927 as being in the United States, is now the most important wireworm pest of sweetpotatoes and other vegetables in the coastal areas of the South Atlantic and eastern Gulf Coast States. Studies on the habits of this insect were continued, with indications that the species has a one-year life cycle and that it can survive drought and high temperatures.

Plans - Research on the biology and control of wireworms will be continued to develop better means of controlling these pests under varying conditions.

Proposals for Committee Consideration -

- C. Expand research to develop methods of utilizing parasites, predators and insect diseases for the control of insect pests of vegetables. Efforts should be intensified to find and establish in this country parasites and predators of leafhoppers, borers, aphids and other important vegetable pests. Provision is urgently needed to permit expansion of studies to find new diseases and to determine their practical usefulness in destroying such pests as the cabbage looper, Mexican bean beetle, cutworms, hornworms and aphids.
- D. Expand work on systemic insecticides for use to control pests of vegetable crops. Available systemic insecticides have shown promising results against aphids, thrips, and mites on a number of different crops and may even prove effective against borers and leaf feeders. Studies should be made to investigate the possible usefulness of these when applied as seed, transplanting water, or foliage treatments on a wide variety of vegetables, with due attention to the nature and persistence of their residues and their effect on quality and flavor of the treated crops.
- E. Expand studies on the development of varieties of vegetable plants resistant to insect attack. Limited research on this problem has concerned sweet corn, onions, peas and tomatoes. Increased cooperative studies should be undertaken by entomologists and plant breeders to develop vegetable varieties resistant to insects in order to help avoid insect damage and reduce the problem of insecticide residues on these important food crops.

Publications

Wireworms and their control on irrigated lands. Lane, M. C. and M. W. Stone. F. B. 1866 USDA (Rev.). April 1954.

Sugar-beet wireworms predaceous on seed-corn maggot. M. W. Stone. Jour. Econ. Ent. Vol. 46, No. 6, p. 1100. Dec. 1953. (issued 1954)

EFFECT OF PESTICIDES ON NATURAL ENEMIES OF VEGETABLE PESTS* - ENT

Progress and Findings - 1954 Recommendation "Initiate research to determine the effect of pesticides on natural enemies of important pests of vegetable crops". (11/13)

Resources permitted only limited research on this subject incidental to other work in progress.

Field observations in Arizona again disclosed that the use of DDT on cantaloups infested by the melon aphid, leafhoppers, leaf miners, thrips and spider mites destroyed many of the parasites and predators of these insects. Also that the use of dieldrin on cantaloup resulted in increased spider mite infestations, indicating that the insecticide may have killed many of the natural enemies.

Laboratory experiments in Arizona disclosed that parathion, malathion, chlorthion and Diazinon were more toxic to such important natural enemies of vegetable pests as ladybird beetles and the striped collops than were heptachlor, Strobane, toxaphene, endrin, DDT, Perthane and dieldrin.

Field studies in California showed that DDT, heptachlor, aldrin, isodrin, endrin, dieldrin, chlordane, Diazinon, toxaphene and parathion were toxic to the natural enemies of lygus bugs on beans, principally lady beetles, predaceous bugs, lacewings and spiders.

Plans - Incidental observations will be continued as circumstances permit, to determine the effect of pesticides on beneficial insects on some of the more important vegetable crops.

Publication

Parasitization of the salt marsh caterpillar in Arizona. E. A. Taylor. Jour. Econ. Ent. Vol. 47, No. 3, pp. 525-530. June 1954.

ROLE OF INSECTS AS VECTORS OF VEGETABLE DISEASES - ENT,HC

Progress and Findings - 1954 Recommendation "Initiate work to determine the role of insects as vectors of vegetable diseases of virus, fungous and bacterial origin." (9/13)

* This subject is one phase of the broader problem on "Toxicological Effects of Insecticides."

A very limited amount of work in this field has been done by both plant pathologists and entomologists during the course of solving specific disease and insect problems. Work done on that basis is reported as parts of projects under other headings. No broad project under the recommended title could be initiated during 1954 for lack of new resources.

Plans - Limited studies will continue insofar as possible incidental to other activities.

- F. Proposal for Committee Consideration - Initiate work to determine the role of insects as vectors of vegetable diseases of virus, fungus and bacterial origin. These studies are fundamental to research on such diseases under way by plant pathologists. To expedite the solution of many vegetable disease problems, the insects responsible for carrying diseases affecting such crops as beans, tomatoes, sweetpotatoes and cucurbits should be determined and methods for their control developed.

RESISTANCE OF INSECTS TO INSECTICIDES - ENT

Progress and Findings - 1954 Recommendation "Expand research on the resistance of insects to insecticides." (7/13)

With facilities available only limited research on this subject was possible.

Field experiments in South Carolina and in Arizona indicated that endrin and toxaphene may prove to be acceptable substitutes for DDT where that material no longer effectively controls the cabbage looper on cole crops and on lettuce. There is no assurance, however, that the insect may not ultimately develop a resistance to these two insecticides. The failure of rotenone dusts to control the Mexican bean beetle during 1954 in certain districts of North Carolina, where this insecticide had formerly given highly satisfactory results, is another striking example of possible insect resistance to insecticides. This insecticide continued to give good results in a comparable series of field experiments in nearby Virginia. Research indicated that the dusts containing malathion or a mixture of malathion and methoxychlor as substitutes for rotenone may solve the problem at least temporarily in the affected districts of North Carolina.

Plans - Research will be continued, as resources permit, to determine the factors responsible for the development of insect resistance to insecticides and to provide effective substitutes for materials which become ineffective.

- G. Proposals for Committee Consideration - Expand research on the resistance of insects to insecticides. The real or apparent resistance of certain species of insects to insecticides, as evidenced by the decreased effectiveness of materials formerly giving satisfactory control, continues to be of much concern. DDT continued to give less satisfactory control than previously of the cabbage looper on cole crops and lettuce and of the imported cabbageworm on cole crops. The failure of rotenone to control the Mexican bean beetle on beans has been reported from some localities. Fundamental studies of insect physiology are particularly needed to provide avenues of approach to a practical solution of the problem.

NEMATODES - HC

Progress and Findings - 1954 Recommendation, "Expand nematology research with vegetable crops to include determination of specific nematodes affecting specific crops in different regions with work on chemicals and biological methods of control. (2/13)

Increased appropriations available July 1, 1954 have made possible an expansion of nematode work in the field of vegetable crops. Organization of this expansion is, at present, proceeding. Additional nematode field laboratories have been established in Auburn, Ala. and Baton Rouge, La. At both of these laboratories, regional nematode problems concerning vegetable production are included in the program.

Tomato - Survey work demonstrated that root knot is increasing in its seriousness over the whole country, in home as well as commercial plantings. Of about 11,000 acres of commercial tomato plantings in Georgia, 90% are estimated to be more or less infested with root knot nematode. Other noxious nematode types such as meadow nematodes, spiral nematodes, dagger nematodes and lance nematodes have also been observed in an increasing number of cases. The National Screening Program involving root knot nematode resistant tomato types has not submitted additional accessions for testing.

Lima Beans - Cooperative work with breeders did not involve additional tests.

Mushroom spawn nematode (Ditylenchus). Activities on this problem were at a standstill through resignation of the investigator in charge.

Onion - In certain regions of northwestern Indiana, meadow nematodes were again observed causing serious damage to onion seedlings. Onion bloat which is caused by two different species of bulb or stem nematodes has been found a serious problem in certain onion districts of New York. Survey work was undertaken in an attempt to establish the origin of these infestations, which by certain growers were blamed on a seed house introducing infected onion sets from the mid-West. A survey of plantings producing such onion sets in the region south of Chicago eventually revealed an infestation in one planting. On the other hand, certain districts in the State of New York have had an infestation of this nematode for many years. An attempt will be made to determine if the seed-producing region in Idaho is still free of this pest.

Melon - During the past season, it was shown that melon growers in Arizona could avoid heavy losses by root-knot nematodes, by avoiding the planting of melons on land previously in cotton, because this crop is quite generally infected and usually increases an infestation. For melon production, therefore, land should be selected that had been previously in summer fallow or had been fumigated with a nematocide, or had been demonstrated by examination to be free of root knot. In Maricopa County, Arizona, 510 acres of melon land was fumigated for nematode control the past season with good success.

Okra - Okra has been shown to be susceptible not only to root-knot nematodes, but also to spiral nematodes, to meadow nematodes and to stubby root nematodes. In Louisiana, for the first time, the reniform nematode was found to attack okra.

Sweetpotatoes - Sweetpotatoes are increasingly affected by root-knot nematodes. On the Eastern Shore of Maryland, the tobacco stunt nematode was, for the first time, observed as a pest on this vegetable.

Carrots - In Maricopa County, Arizona, 440 acres of land to be planted to carrots were fumigated for root-knot nematode control. Near Buffalo, N. Y., dagger nematodes caused carrots to be unsalable. Plants had a heavy top and a very hairy root.

Peppers - In Arizona a pepper planting was observed suffering from root knot and a heavy attack of meadow nematodes. Fumigation of the infested land demonstrated that the yield from 8 acres so treated, was better than that from 30 non-treated acres.

Eggplants - It has been shown that the golden nematode of potatoes, contrary to previous statements, does attack the eggplant and is able to propagate on this host.

At our laboratory in Auburn, Ala., and in cooperation with the Alabama Experiment Station, research is being initiated to determine what environmental factors have a controlling effect on nematode infestations and how various agronomic practices affect nematode infestations in crop land.

Plans - Will expand plant nematode work through the establishment of additional field work in one of the North Central States, in the lower Rio Grande Valley and in a region with extensive muck soil agriculture. In the latter instance nematodes attacking vegetables and their control in these soil types will be given special attention.

- H. Proposal for Committee Consideration - Continue to expand research on nematodes as a limiting factor in vegetable production with emphasis on improvement of preventive measures and chemical control methods.

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PRODUCTION PRACTICES, MATERIALS AND EQUIPMENT

TOXICOLOGICAL EFFECTS OF INSECTICIDES - ENT, HC, HN AND STATES

Progress and Findings - 1954 Recommendation "Expand the work on determining the direct and indirect effect of insecticides, fungicides and herbicides on soils, plants and animals with special attention to residues in or on the edible portion of vegetables and the effects on chemical composition and quality." (1/13)

A slight increase in resources permitted a limited expansion of this work.

Special attention was devoted to studies on (1) the insecticide residues remaining in or on edible parts of vegetables; (2) the flavor of the harvested product; and (3) the growth of seeds or plants treated with or planted in soil where insecticides were applied, including studies on the persistence of the insecticides in the soil.

Analyses by cooperating chemists of samples of the edible parts of lettuce heads, treated with malathion, dieldrin or endrin at dosages ordinarily used to control insects, disclosed residues of less than 0.1 ppm of any of these insecticides at harvest. Cabbage heads treated with toxaphene, endrin or demeton had residues of less than 1 ppm on the marketed portion. Chemical analyses of ripe tomatoes grown in a greenhouse where demeton had been applied to the soil revealed residues of 0.2 ppm in the fruits harvested 52 days after treatment with 10, 25 and 50 pound dosages. Less than 0.1 ppm of dieldrin or aldrin residues were found in sweetpotatoes harvested from field plots receiving soil surface applications of these insecticides. Malathion residues on pea vines averaged 3.5 ppm 7 days after application and 1.7 ppm after 10 days. Neither the pods or the shelled peas showed any detectable residues of demeton 3 weeks after green peas were sprayed with this systemic insecticide. Dried lima beans from plants dusted with demeton or Ovotran (K6451) contained a maximum of 0.15 ppm of either of these materials. No significant residues of toxaphene or chlordane were found in dried lima beans harvested from plots where the soil had received 4 annual broadcast applications of these insecticides. Negative results were also obtained in dried lima beans from plots receiving single broadcast applications of chlordane or heptachlor.

In experiments in Maryland malathion was applied to beets, broccoli, kale, lettuce, okra, snap beans and tomatoes, in the form of dusts, emulsions and wettable powders, at dosages slightly higher than ordinarily used for insect control. Chemical analyses showed that washing the edible parts of the plants in ordinary water for 60 seconds reduced the residues below 1 ppm on all the treated vegetables except lettuce treated with the wettable powder spray and broccoli receiving either spray. From these experiments it appears that malathion residues can be reduced to low levels if the vegetables are subjected to the usual washing procedures in the preparation of foods for the table or for processing.

A taste panel of HN reported that no significant difference in flavor was found between untreated yellow summer squash and those given weekly applications of lindane up to the time of harvest.

Research on the toxicological effects of insecticides on plants revealed that the mixing of DDT, aldrin, dieldrin, chlordane, endrin, or toxaphene in the soil at dosages effective in the control of wireworms did not cause detectable injury to beans and other vegetables or adversely affect yields. Lindane had a tendency to retard the germination of seed treated with this material. Chlordane, toxaphene, lindane, aldrin, dieldrin and isodrin had an injurious effect on the germination of the seed of field beans in Idaho when used as a slurry treatment of the seed, in combination with a fungicide and a sticker. Similar treatments of onion seed with aldrin, dieldrin and heptachlor did not cause adverse affects.

A manuscript for a Technical Bulletin on the work in four States with direct applications to the soil briefly reviewed in last year's report, has been submitted for publication.

Heavy direct single dosages of a wide range of chlorinated hydrocarbons still impair plant growth in certain soils after several years. Single heavy dosages to the soil appear more persistent and harmful after a period of years than do accumulative usage of equal amounts applied in small increments to crop foliage for the same period of years.

As indicated above, a given accumulative foliage application over a period of years, although very heavy, appears less harmful at the end of that time than does the residue of a single direct soil application that was made at the beginning of the period. Some part of the chlorinated hydrocarbons may be removed by the harvested crop but probably very little. It appears more likely that the substances decompose or volatilize more readily on plant foliage than in soil, and therefore less of the total amount applied ever reaches the soil.

An untreated crop of turnips grown following more than 2 years of heavy, repeated sprayings revealed no more organic chlorine in the edible roots than did those from check plots. Carrots, on the other hand, from similar but not identically treated plots showed considerable amounts of organic chlorine following use of several chlorinated hydrocarbons. The 1954 figures are not yet complete but carrots took up dieldrin, endrin, and isodrin from soils of plots that had grown heavily sprayed crops for a 2-year period ending 1 year before. No significant amount of aldrin was found in the carrots.

Yield data in 1954 from the "accumulation" series on unsprayed crops of carrots, turnips, and snap beans show no significant effect on yield although residues of DDT and methoxychlor appeared to depress yield of Stringless Black Valentine non-significantly.

The accumulations from heavy sprayings with BHC impaired flavor of carrots and beans, but there was no very definite effect of any of the several other substances on flavor.

Plans - Work on the toxicological effects of insecticides will be continued insofar as resources permit, with emphasis on the development of data most urgently needed to permit the issuance of recommendations for new or improved insecticidal control measures for insects affecting various vegetable crops. The very heavy dosages of substances heretofore used in these studies are being discontinued; Recommended, and 2 to 3 times recommended, dosages will be used mainly. Special attention will be given to the physiological action of toxic amounts or of amounts sufficient to enter plants.

- I. Proposal for Committee Consideration - Expand the work of determining the direct and indirect effects of insecticides, fungicides and herbicides on soils, plants and animals with special attention to residues in or on the edible portion of vegetables and the effects on chemical composition and quality.

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SWEETPOTATO CULTURE AND HARVESTING - HC

Progress and Findings - Tests of methods of soil preparation and of fumigation for nematode control were undertaken again at Meridian, Miss., but no reliable results were obtained because of serious drought.

Sweetpotatoes were harvested under widely contrasting conditions of temperature and soil moisture in efforts to identify some factor associated with harvesting conditions and subsequent keeping quality. It was confirmed that frosting of the vines as such, does not impair keeping quality. Gas analyses of tissues of sweetpotatoes harvested in cold, wet weather showed rather consistently low oxygen and high carbon dioxide in such roots, which generally do not keep as well in storage as do roots harvested in mild weather from soils not excessively wet. The significance of these findings is not yet clear. (Work cooperative with AMS).

Plans - Work will continue along recent lines.

MUSHROOM CULTURE - HC

Progress and Findings - Work continued on the improvement of cultural practices and control of diseases in the pilot plant at Beltsville. Ventilation studies indicate that at least two cubic feet of fresh air per hour per square foot of bed space are needed for normal growth and yields. Until these studies were made no quantitative information was available on ventilation requirements.

Plans - Work will continue on nutrient and environmental factors affecting growth and development of mushrooms.

VEGETABLE SEEDS - HC

Progress and Findings

Bean - Plant growth and productiveness in a controlled light room were studied in three varieties of beans, seed of which had been held four years under two different conditions: (1) Commercial partially controlled storage in Mercedes, Texas, at about 65° F., and 65% relative humidity, and (2) Warehouse in Idaho. Seed from partially controlled storage showed a high percentage germination but the plants

thereof grew only half as tall as those from the Idaho warehouse. The weight per plant, number and weight of usable pods at first harvest, and number of branches per plant were only about 75 to 80 percent as great in the southern storage lots as in the Idaho warehouse lots. The physiology of these differences needs to be studied.

Cooperative studies of effects of irrigation on seed beans are being initiated with the Idaho Experiment Station.

Peas - Studies are being initiated on the physiological factors affecting production potentials of pea seeds. A new artificially lighted and controlled growth room is being provided for these studies and seed samples are being assembled through the active cooperation of seedsmen and processors. Special attention will be given to possible effects of various field practices on the potential productivity of these seeds.

Lettuce - In the study of irrigation and fertilizer treatments of Blackseeded Simpson lettuce in the Cache Valley of Utah, seed yields in 1953 were highest (947 pounds per acre) at the highest moisture level used (five irrigations); a very respectable seed yield (553 pounds per acre) was produced with no irrigation. Added nitrogen and phosphorus did not result in a statistically significant increase in yield. Seed germination was uniformly high for all treatments. Complete yields are not yet available for a similar study in 1954, using overwintered plants of Great Lakes lettuce, but it is clear that again moisture level has a marked effect on seed yield but added nutrients have very little influence.

Cabbage - Studies on the effect of pruning cabbage seed plants have been conducted for several years in an effort to reduce plant height, eliminate the costly staking and tying operation and to aid in disease control. Since the work has failed to establish a practical application of the method under Pacific Northwestern conditions or any marked benefits under present cultural practices these experiments will not be continued.

Carrot - A study of the relation of bees and other insects to the pollination of carrot was started in 1954 in cooperation with Entomology Research Branch. Final results are not yet available, but it is clear that insects are very important in the pollination of the carrot seed crop.

Onion - Studies in cooperation with the Weed Investigations Section, both in 1953 and in 1954, indicate satisfactory control of annual weeds in seed onions with about 3 pounds per acre of 2,4-D (acid) or $1\frac{1}{2}$ to 2 pounds of CMU applied when the onions are beginning to bolt.

Light and seeds - Further information has been gained on the inter-relations of light, temperature, and other factors in their effects on seed germination. In light sensitive seeds the reversible light reaction stands at or near the beginning of the series of reactions involved in germination. Seed of Lepidium virginicum was fully imbibed with water at 15° C., in the dark. If kept in the dark at 15° or if moved to 25° no marked change occurred. When, however, it was briefly exposed to light just before moving to 25° very quick germination occurred at that temperature. Treating the seed with weak solutions of nitrates or thiourea also hastens germination following light exposure.

Grand Rapids lettuce seed conditioned to a germinable and to a dormant condition by the light mechanism are stored at four temperatures to be tested periodically. The experiment is to aid in understanding the principles of physiological interactions that occur in seeds during the resting stage and of the maintenance of seed viability.

Plans - Work will proceed along lines indicated above.

Publications

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WEED INVESTIGATIONS - FC

Progress and Findings

Asparagus - Sodium 2,4-dichlorophenoxyethyl sulfate (SES) and 3-chlorophenyl-1,1-dimethyl-urea (CMU) applied pre-emergence have effectively controlled annual weeds at rates which did not reduce yields. Control with SES has been somewhat erratic and of shorter duration than control with CMU. Taste tests of asparagus treated with SES indicated off-flavor on that from plots treated during the cutting season. Tests are in progress to measure possible effects of CMU on taste.

Sweet Corn - Certain esters of trichlorobenzoic acid showed considerable promise as pre-emergence herbicides in tests conducted in 1950-53. Approximately two and one-half times as much trichlorobenzoic acid was needed as 2,4-D for satisfactory control, but the experimental chemicals were less hazardous to both sweet corn and adjacent crops. Other chemicals tested for pre-emergence use including CMU, SES, SESIN, and DNOSBP were unsatisfactory due to either poor weed control or injury to sweet corn. In 1953 and 1954, DNOSBP applied at come-up of sweet corn resulted in near perfect control of annual weeds with no injury of sweet corn. This is a most promising method of control since by timing the application with emergence of weeds, consistent control is probable and less DNOSBP will be needed than with pre-emergence applications.

Tomatoes - Sodium 2,4,5-trichlorophenoxyethyl sulfate (Natrín) and related chemicals have been under investigation in 1953 and 1954 as possible herbicides in tomatoes. Weeds are commonly a problem in tomatoes after it is no longer possible to cultivate. Results indicate considerable promise for application made at about the time of the last cultivation. Earlier treatment may result in injury particularly if sufficient rainfall to move the chemical down to the tomato roots occurs while the plant is still elaborating its root system.

Cucurbits - Tests in 1953 showed muskmelons and cucumbers to be tolerant of rates of Alanap-1 necessary to control weeds whereas squash was not sufficiently tolerant. Effective control was obtained with 2 and 4 pounds applied pre-emergence; 4 pounds resulted in consistent stunting of cucumbers. There was an indication of a difference between cucumber varieties in tolerance for Alanap-1. In an irrigation study, weed control with an application immediately prior to irrigating was superior to that with an application immediately after.

Spinach - CIPC was applied to over-wintered spinach for the control of chickweed in February of 1953 and 1954. Chickweed was effectively controlled in both years with no apparent injury of the spinach.

Plans - Work will continue along present lines.

- J. Proposal for Committee Consideration - Expand research to develop effective weed control in most vegetable crops since, in all but a few, present methods and chemicals are inadequate.

EQUIPMENT FOR APPLICATION OF PESTICIDES - ENT, AE and States

Progress and Findings - 1954 Recommendation "Expand work on the improvement of equipment and methods of aerial and ground application of pesticides." (10/13)

Resources did not permit an expansion of this work, but some progress has been made with the limited funds available. Some of the findings reported, although conducted under other projects, are applicable insofar as the equipment is concerned.

Experiments with equipment and methods of application of insecticides to several types of crops with aircraft were continued in the Pacific Northwest in cooperation with the Oregon, Washington and Idaho Agricultural Experiment Stations and with pea processors. Most of this work concerned aerial spray applications to peas, sweet corn and beans.

Concentrated spray applications of DDT and malathion were found to be at least as effective against the pea weevil as dusts at comparable rates of application. Indications were that excellent control was possible at flight elevations as high as 75-100 feet or more -- an important point in some areas where trees and poles in conjunction with small and irregular fields would otherwise make aerial applications excessively hazardous or impossible. It is concluded that aerial spray applications of DDT and malathion at one pound per acre can be recommended for pea weevil control at flight elevations of 10 to 100 feet. For 10 foot flights, swaths should be flagged at about 65 feet, while at 25 to 100 feet a 100-foot swath can be flown.

In airplane spray tests for control of the corn earworm, in cooperation with the Washington State Irrigation Experiment Station at Prosser, fine and medium spray applications were made to replicated plots of sweet corn. In one set of plots the spray was fortified by the addition of parathion. Clear cut conclusions are impossible but it appears that, in conformity to theory, fine sprays were most effective. It also appears possible that observed results may have come from control of the adults rather than the larvae.

Airplane spray tests for control of nitidulid beetles on pole beans with chlorthion and malathion were made in Oregon, in cooperation with the Oregon State College. Adequate commercial control was not obtained, nor was there a difference between the malathion and chlorthion.

Studies on spray distribution patterns from various nozzle arrangements on biplane aircraft were continued. This phase of the work, as far as Stearman and W3N aircraft are concerned, may be considered nearly completed, reasonably satisfactory nozzle arrangements having now been developed. Work along this line should be diverted to studies of other types of aircraft and to dust distribution studies -- a phase long contemplated but not yet undertaken.

Cooperative work was continued with the South Carolina Agricultural Experiment Station on improving methods of applying insecticides to vegetables with ground equipment. Data were obtained on the relative effectiveness of insecticide sprays applied with a hydraulic sprayer at various gallonages and with several pressures and nozzle arrangements. Comparable dosages of a parathion emulsion gave approximately the same degree of cabbage aphid control on cabbage when applied in 10, 20, and 100 gallons of water per acre. The 10-gallon dosage was as effective as a dust applied with conventional equipment. Use of a cloth hood over the dust machine nozzles tended to increase the aphid kill, but did not appear to be very practical. No outstanding differences in the degree of caterpillar control on cabbage were apparent when a DDT-toxaphene combination, in emulsion form, was applied in 5, 10, 20, 50 and 100 gallons of water per acre with the aforementioned hydraulic sprayer and when applied at 10 gallons per acre in a small commercial mist blower. When compared with a conventional dust application, the sprays tended to be most effective after one application. A cloth hood over the duster tended to increase the effectiveness of the dust application. There have been no outstanding differences in the effectiveness in insect and disease control on cucumbers of a combination of lindane and zineb applied in 12, 25, 50 and 100 gallons of water per acre. The pressure and nozzle arrangement were varied in the case of the 25-gallon dosage. Similar results were obtained when parathion was applied in the same manner to cucumbers for control of leaf miners.

The study of the effect of pesticides on application equipment in cooperation with industry groups was continued. Two general lines of approach to the problem were undertaken: Investigation of protective coatings for tanks and investigation of construction materials for greater corrosion resistance. A correlation of all data presently available on the resistance of coatings has shown that

out of the vast varieties of coatings, only a few have shown acceptable resistance to a majority of the pesticides. For a study of construction materials, cooperation was secured with a leading manufacturer of alloys in conducting spool type specimen tests under actual field conditions. Of the 17 different alloys tested under a wide variety of pesticide and operating-conditions exposure, certain over-all observations are apparent: 1. The stainless steels (types 304, 316) and Monel were highly corrosion resistant in all of the tests. 2. Nickel and aluminum showed slight tendencies toward pitting in a few of the tests. 3. The low alloy steels did not appear to offer any significant improvement over carbon steel. 4. In most cases, zinc showed a sufficiently high corrosion rate to indicate that galvanized sheet would lose its zinc coating in a year or less. 5. Ni-Resist, phosphor bronze, and 85-5-5-5 bronze showed reasonable good corrosion resistance and were consistently several times better than cast iron.

Granular type of dust of Attaclay and Tobacco dust, 30/60 mesh screen and impregnated with DDT, EPN, and heptachlor were tested for corn borer control. Because of the packing and bridging characteristics of these dusts conventional dusters did not function satisfactorily. An experimental modified grass seeder was used for an alternate method of application. All materials gave reasonably good borer control with the best reduction in borer population at 89 percent. The large particle sizes of these dusts makes it possible to apply them under windy conditions without excessive drift.

Studies of nozzle arrangements and volumes were continued on second brood corn borers. DDT was the only chemical used in this test and was applied at 5, 10, and 20 gallons per acre. Nozzle arrangements include two 80 degree nozzles per row, two 110 degree nozzles per row, four 65 degree nozzles per row, and a uniform spacing of 80 degree nozzles along the boom for overhead application. There were no significant differences shown between different application rates or between various nozzle arrangements. The overhead uniformly spaced nozzle boom is most desirable from simplicity and operation standpoints.

Experiments for control of corn borers on sweet corn in Ohio included tests of insecticide materials, application rates and nozzle arrangements. Applications made at 10, 20, and 100 gallons per acre rate showed no significant difference in borer control. Nozzle arrangements using 1, 2, and 3 nozzles per row gave no significant difference in borer control. It appears that nozzles spaced uniformly along the boom and application made above the plants as a sheet or brush type treatment is as effective as the complicated nozzle arrangements previously used.

In cooperation with the Division of Forest Insect Research, Forest Service (formerly Bureau of EPQ), a series of airplane spray tests was made over open ground with a Stearman plane to compare the spray distribution from various arrangements of nozzles on the spray boom. At heights of 50 feet there was no practical difference in spray distribution whether the nozzles were placed along the full wing span or along only the inboard half of the boom, and either location provided efficient distribution.

Plans - It is expected that investigations on formulations and equipment for the application of pesticides will be continued along present lines with the exception of the work on the control of the pea aphid on canning peas in the Northwest. This latter work has been terminated since it is felt that recommended control practices for pea aphid control are now adequate, at least for the present. In studies in the Northwest, emphasis has been diverted to other control problems in the area, including the green peach aphid on potatoes, corn ear worm on sweet corn, and nitidulids on pole beans.

- K. Proposal for Committee Consideration - Expand work on the improvement of equipment and methods of aerial and ground application of pesticides.

Publications

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PRODUCTION AND HARVESTING MACHINERY - AE

Progress and Findings - 1954 Recommendation, "Initiate research to develop and improve farm machinery for the production and harvesting of commercial vegetables, deciduous fruit and tree nut crops." (6/13)

No formal project has been initiated on farm machinery for production and harvesting of commercial vegetables because of lack of funds. However, contacts have been made with Agricultural Engineering Departments in the various States for the purpose of obtaining data and references on commercial or experimental machines. Some field contacts were made in California. Only limited information has been obtained so far. A report will be available for the meeting of the Advisory Committee, at which time their advice will be asked concerning the best solutions for some of the problems inherent in this type of activity.

Plans - Follow up on present contacts and make new ones for obtaining as much information as possible about experimental production and harvesting machinery for commercial vegetable crops insofar as present funds and personnel will allow.

- L. Proposal for Committee Consideration - Expand work in obtaining information on vegetable harvesting machinery and initiate work which would help lead to faster development of machines for farm use in producing and harvesting of commercial vegetable crops.

PRODUCTION ECONOMICS

ECONOMICS OF ADJUSTING PRODUCTION OF SURPLUS PRODUCTS - PERB, States

Progress and Findings: 1954 Recommendation, "Expand economic research on farm adjustments necessitated by reduction in production of major commodities like wheat and cotton.

A small start is being made in the current fiscal year in economic research on farm adjustments necessitated by a reduction in market outlets for major commodities. Such studies are being initiated in the butterfat areas of Iowa and southern Minnesota, in some of the wheat areas in the Great Plains and Pacific Northwest, and in some of the major cotton areas. Opportunities both to reduce unit costs of production and to shift to alternative types of production, as well as the effects of using diverted acres for producing alternative commodities are to be considered in seeking guides to profitable alternative uses for land and other resources no longer needed in butterfat, wheat, and cotton production.

Plans - are to expedite these analyses as rapidly as possible.

- M. Proposals for Committee Consideration - An expansion is needed in economic research concerned with production adjustments on farms faced with a reduction in market outlets. The problem is even more urgent now than it was last year. A small start in this area is being made this year but studies are needed in all of the major type-of-farming areas where butterfat, wheat, cotton, and other surplus products are produced. Information is needed on the production and income potentials of farming systems which include more grass and legumes, on the problems of adjustment in organization and operation of different types of farms during the transition period of the next few years, and on profitable uses of surplus land which would avoid the creation of new surplus problems for the producers of other commodities, such as vegetables.

B. Proposals for Committee Consideration

PRODUCTION RESEARCH

Page No.

A. A National Seed Storage Laboratory should be developed for the purpose of preserving collections of foreign and domestic plant species, varieties, and strains that are becoming difficult to obtain and also for preserving valuable existing stocks in the hands of breeders.	2
B. Initiate substantial research on the effects of cultural methods, soil management, crop sequences, use of crop residues, manures and green manures, and other production practices upon the micro-population of the soil and the inter-relations of these factors with the build-up or suppression of soil-borne diseases of crop plants.	19
C. Expand research to develop methods of utilizing parasites, predators and insect diseases for the control of insect pests of vegetables.	39
D. Expand work on systemic insecticides for use to control pests of vegetable crops.	39
E. Expand studies on the development of varieties of vegetable plants resistant to insect attack. . .	39
F. Initiate work to determine the role of insects as vectors of vegetable diseases of virus, fungous and bacterial origin.	41
G. Expand research on the resistance of insects to insecticides.	42
H. Continue to expand research on nematodes as a limiting factor in vegetable production with emphasis on improvement of preventive measures and chemical control methods.	44
I. Expand the work of determining the direct and indirect effect of insecticides, fungicides and herbicides on soils, plants and animals with special attention to residues in or on the edible portion of vegetables and the effects on chemical composition and quality. . .	48
J. Expand research to develop effective weed control in most vegetable crops since, in all but a few, present methods and chemicals are inadequate. . . .	53
K. Expand work on the improvement of equipment and methods of aerial and ground application of pesticides.	56
L. Expand work in obtaining information on vegetable harvesting machinery and initiate work which would help lead to faster development of machines for farm use in producing and harvesting of commercial vegetable crops.	57
M. An expansion is needed in economic research concerned with production adjustments on farms faced with a reduction in market outlets.	58

II. UTILIZATION RESEARCH

A. Progress on Work Under Way

CONSUMPTION AND HUMAN NUTRITION

YIELDS AND LOSSES FROM DIFFERENT MARKET QUALITIES ON PREPARATION METHODS - HN

Progress and Findings - 1954 Recommendation, "Initiate studies of a laboratory nature to determine the losses and obtainable yields from vegetables of different market qualities and from common methods of preparation and handling in the kitchen." (12/18)

No new funds were available for initiating a major attack on the problem of yields and losses. Work has continued, however, on collecting available laboratory data obtained during studies of food preparation, quality or nutritive value. In addition, studies of losses and yields from selected fruits, vegetables, and meats in the regular food service of two hospitals and two colleges have been initiated under contract.

Considerable variability is found in the cooked or edible yield of many foods. Among fresh vegetables used in the course of several laboratory studies, yields of raw prepared food ranged from a low of 17 percent in a sample of lima beans to a maximum of 98 percent for yellow crookneck and Zucchini squash. With specific vegetables yield variability was smaller but differed with the product. For example, the extreme yields among 15 lots of lima beans after removal of pods were 17 and 76 percent; among 58 lots of green beans after trimming, 72 to 97 percent; and for the yellow crookneck and Zucchini squash, yields ranged from 74 to 98 percent. Yields of raw prepared food from two badly crushed lots of kale were only 18 and 25 percent, while yields of spinach ranged from 32 to 91 percent. Yields of raw prepared food from root crops (beets, carrots, parsnips, rutabagas, sweetpotatoes, turnips) were most frequently in the range of 75 to 85 percent - lowest observed yields were 58 and 60 percent for carrots and turnips, respectively. Yields of raw prepared food from broccoli, Brussels sprouts, cabbage, cucumbers, head lettuce, okra and tomatoes most frequently fell in the range of 70 to 95 percent of the as purchased product, those from cauliflower and celery from approximately 30 to 60 percent. Yields from peas were highly variable regardless of apparent quality of the raw product. Most yields were in the range of 40 to 50 percent. The wide-range in yields for the same vegetable emphasize the complexity of the problem of buying to furnish a required number of portions of a given size, for example, to meet USDA regulations for Type A lunches.

These new data will be incorporated with any data available from other sources in drafting tables of yields and losses. Such tables will provide not only an "average" figure for yield but also show the range or some other indication of variability.

Plans - During this fiscal year, the limited yield data available will be used to develop a guide for school lunch managers on quantities to buy for serving school lunches. As many additional laboratory studies as possible will be made to obtain urgently needed data on cooked yields from frozen foods, mostly vegetables. See proposal for Committee consideration.

- A. Proposal for Committee Consideration - Expand laboratory work and studies of "in practice" situation to determine losses and usable yields from vegetables of different market quality, fresh and frozen, and from common methods of handling in the kitchen. The guide for school lunches to be drafted this year will be based on very scanty data on many foods, including fruits. Systematic research to fill the many gaps in available data must be accelerated in order to provide home and institutional buyers with adequate guides to quantities to purchase in order to provide nutritionally adequate and appetizing meals with a minimum of waste. Such data will also be useful to producers and distributors in indicating the variability in quality and yield of many commodities and thus providing a basis for prevention of unnecessary waste or spoilage in production and marketing.

HOUSEHOLD USES OF SELECTED VEGETABLES - HE

Progress and Findings - 1954 Recommendation, "Initiate survey work to determine the prevalence of various household practices in the use, care and storage which would affect the quantity, quality, and nutritive value of vegetables as eaten." (13/18)

Surveys of household practices in the use in the home of several commodities have been made in three cities. Among the foods included in the surveys were cabbage, carrots and canned tomatoes. These vegetables were selected because their nutritive contribution to diets depends on whether they are served raw or in cooked dishes, and no basis for an estimate of the share served raw has been available. In these surveys, representative samples of homemakers were asked how many meals each of these vegetables were served during the previous week and the method of serving.

In each city (Birmingham, Indianapolis, and Everett, Wash.) cabbage was served raw as slaw or salad at more meals than it was served cooked. In Indianapolis the ratio was as high as two meals of raw cabbage to one of cooked. For carrots the favorite method of serving differed for the three cities. In Birmingham and Indianapolis raw carrots were slightly more popular than cooked; in Everett, carrots were served more frequently cooked than raw. In each of the three cities about a fifth of the households had some raw carrots between meals during the week--some of these only between meals. Cooking together with other foods was the most popular method of serving canned tomatoes during the survey week in the three cities, but about a fifth of the canned tomatoes used were served unheated.

Information of the type obtained in these surveys provides much background information for use in educational and marketing programs and in programs of research in human nutrition, home economics and utilization of agricultural products.

Plans - Analysis of the data from the surveys in the three cities will be completed and a publication prepared.

- B. Proposal for Committee Consideration - Expand the survey work on household uses of foods to obtain data in other communities and on other vegetables. The findings from the three surveys made in 1953 indicate regional and city-size differences probably exist but the surveys are too few to draw quantitative conclusions about such differences.

FAMILY FOOD CONSUMPTION AND DIETARY LEVELS - HN & HE

Progress and Findings - As one indication of how well our national food supply provides for the nutritional needs of the population, the nutritive content of the per capita food supply is computed at least once a year, permitting analysis of the trends since 1909. A revision of this series recently published shows average values for calories, and 11 nutrients, as well as the proportion of each nutrient furnished by each of 12 food groups. The average amount of folic acid, one of the B-vitamins only recently included in the calculations, ranged from 0.120 mg. to 0.151 mg. per person per day over the 43 year period. How well these levels meet human requirements is not known at present. Leafy, green and yellow vegetables furnished a fourth of the total folic acid, other vegetables and fruit 10 percent, potatoes and sweetpotatoes 5 percent and citrus and tomatoes 5 percent. Average values for several nutrients were somewhat lower in 1953 than in the peak years of 1945-46; ascorbic acid was down 15 percent and vitamin A 18 percent, associated with smaller consumption of fruits and vegetables.

Tabulation and analysis of the survey of food consumption of rural families in the North Central region has continued and publications are being prepared. Some data on family food expenditures, the money value of home-produced food, the quantities of home canned and home frozen foods, and the nutritive adequacy of the diets have been included in the 1955 Agricultural Outlook Charts. Average expenditures for food indicate that in this region the market for food sales to farm families is about three-fourths as large per family as that to rural nonfarm and city families. The diets of the farm families, however, were better than those of the rural nonfarm families due in part to large supplies of home-produced foods.

At least a fifth of the rural nonfarm families had diets that furnished less than recommended amounts of the 5 vitamins studied, a third, with respect to calcium. This indicates that a large potential market exists among rural nonfarm families for those fruits and vegetables that furnish vitamins A and C, for those grains, meats, and other foods that are good sources of the B-vitamins, and for milk, the principal source of calcium.

Plans - Computations of the nutritive value of the food supply will be continued as a basis for studying trends.

Further analysis and publication of data from the survey (contract) of food consumption of North Central rural families will be made.

Because no recent nationwide survey of food consumption and dietary levels has been made, plans have been made for a large-scale survey in the spring of 1955 (contract, cooperative with AMS). Such a survey will be large enough to provide regional data and separate averages for farm, rural nonfarm and urban groups. Because of current agricultural surpluses, analyses to locate underconsuming groups on a regional basis and to determine what shortages exist are especially timely. Surveys of the consumption of all foods families eat are needed to determine a) the nutritive value of diets, b) the importance of individual foods in the total food budget, and c) the interrelationships in the consumption of commodities.

- C. Proposal for Committee Consideration - Expand analyses of the food consumption survey data collected in 1955 to show (1) interrelationships among nutrients and dietary patterns, (2) the relative economy of vegetables in the light of present-day prices, consumption, and marketing practices, and (3) changes in the income-consumption relationships for foods since 1948. Such analyses cannot be made with existing staff and cannot be advantageously made under contract. (The survey data are to be collected and tabulated under contract. Present staff is fully occupied planning, supervising, and preparing descriptive reports of the data.)

Publications

Agriculture Outlook Charts, 1955. (Three charts on food consumption and dietary levels.) October 1954.

Food Consumption of Farm Families, Meeker and Wright Counties, Minnesota, 1950. F. Clark and C. LeBovit, U.S.D.A. AIB-127. 1954.

Food Consumption of Urban Families in the United States with an Appraisal of Methods of Analysis. F. Clark, J. Murray, G. S. Weiss, and E. Grossman, U.S. D.A. AIB-132. 1954.

Tables page 3, 37 and 38 in National Food Situation, USDA, August 1954. (Supplement to Consumption of Food in the U. S. 1909-52, Agr. Handbook 62, Nov. 1953.)

FOOD HABITS OF INDIVIDUALS - HN

Progress and Findings - A cooperative study carried out in one State of the Western Region on the food habits of children with, and without, rheumatic fever has provided information on consumption of vegetables and their contribution to the diets of these children. A significant observation made in these studies was that low intakes of calcium, iron, thiamine, and ascorbic acid by some of the groups of children studied would have been corrected by increased use of vegetables, citrus fruits and tomatoes, milk and eggs. While the boys ate larger quantities of foods than the girls, the percentages of each nutrient obtained from the various food groups were about the same for both sexes. Tomatoes with citrus fruits furnished 37 to 40 percent of the dietary ascorbic acid. Green and yellow vegetables contributed an additional 12 percent of this vitamin, as well as almost 25 percent of the total vitamin A in the diets. Vegetables also made significant contributions - 5 to 10 percent - to the total iron, thiamine, and niacin in the diets.

Plans - Data from similar cooperative studies of the food habits of older women in the North Central Region and of adolescents in other States of the Western Region are being evaluated and prepared for publication.

Evaluation of dietary data collected during a 3-year study of a selected sample of Negro children before and after starting to school will be completed. The data will be analyzed for possible correlation of the dietary findings with clinical findings and biochemical indicators of nutritional status.

Publications

"Children With and Without Rheumatic Fever. II. Food Habits."
E. B. Wilcox and Leora S. Galloway. Journal of the American
Dietetic Association, vol. 30, No. 5, May 1954.

HUMAN REQUIREMENTS, DIETS AND PHYSIOLOGICAL AVAILABILITY OF NUTRIENTS - HN

Progress and Findings - Work has continued under contract to determine the energy requirements of young women (20-30) and of older women (50-60) engaged in the same selected physical activities; thiamine and riboflavin requirements of college women and women over 50 under similar dietary conditions; amino acid requirements of women; fatty acid requirements of infants and children; thiamine and riboflavin requirements of adolescent boys. Also continuing are cooperative studies of diets of older men in relation to their physical state. Just initiated under contract is a study of the availability of amino acids from selected foods. Results of studies of the physiological availability of ascorbic acid have been evaluated and are being prepared for publication.

Plans - A bulletin will be published presenting the results of research on the development and application of a standardized diet for use in determining requirements and physiological availability of nutrients. New research is needed along several lines. See proposals.

- D. Proposals for Committee Consideration - Expand research to obtain needed data on availability to the human body of important nutrients in foods, such as amino acids from various food sources. Because certain nutrients may be present in food but not utilized by the body, data on food composition needs to be supplemented with information on the physiological availability of the nutrients. The research should include studies of factors in composition of the food and the diet, and in metabolism, which affect availability of nutrients from foods. Such fundamental information, based on studies of human subjects, is needed for realistic appraisal of the nutritive value of foods and of dietary practices, and in planning for improved nutrition in all age groups.

Publications

"Influence of Carbohydrate, Nitrogen Source and Prior State of Nutrition on Nitrogen Balance and Liver Composition in the Adult Rat." M. W. Marshall and M. Womack. Jour. of Nutr. 52, 51-64, 1954.

"Food Habits of Iowa School Children -- Breakfast." V. D. Sidwell and E. S. Eppright. Jour. Home Ec. 45: 401-405, 1953.

"Relationships of Nutrient Levels of Diets of Iowa School Children to Physical and Biochemical Measurements." E. S. Eppright, V. D. Sidwell, and C. Roderuck. Abstract in Fed. Proc. 13: 456, 1954.

"Nutritional Status of the Aging. I. Hematology of 577 Normal Men and Women Over 50 Years of Age." H. L. Gillum and A. F. Morgan. Abstract in Fed. Proc. 13: 469, 1954.

COMPOSITION, QUALITY EVALUATION AND PRESERVATION

CHEMICAL CONSTITUENTS OF VEGETABLES - WU

Progress and Findings - 1954 Recommendation "Initiate a comprehensive and intensive study of the kind and quantities of the chemical constituents of vegetables, as a necessary prelude to understanding and controlling the many factors which affect the quality of processed vegetable products." (1/18)

Work under this recommendation has been limited to continuation of investigations in progress at the current level of activity at Western Utilization Research Branch because of limitations in funds. At the Eastern Regional Research Branch, research on the constituents of tomatoes and cabbage was expanded. No funds were available at the Southern Utilization Research Branch for initiation of new work or for expansion under current approved projects in this field. Some progress has been made at SURB under existing projects on sweet potatoes and very limited service-exploratory work relating to other commodities has been possible.

CARBOHYDRATE CONSTITUENTS OF TOMATOES - WU

Progress and Findings - Improved procedures for the removal of more and more water from the tomato are constantly being investigated, in order to provide more economical methods for transporting and

storing of tomato solids. The production of tomato pastes of high solids content and the preparation of dried tomato flakes or powders have led to problems in processing and storage stability. An investigation of composition, dealing primarily with the carbohydrate constituents, of the tomato was therefore initiated to aid in solving some of these problems.

About four-fifths of the tomato solids are soluble in alcohol. About 75% of this alcohol-soluble fraction are free sugars (one class of carbohydrates), which were found to be primarily fructose and glucose plus some sucrose and a trace of a ketopheptulose. Ash and organic acids accounted for a portion of the other 25% of alcohol-soluble fraction.

The other one-fifth of tomato solids are insoluble in alcohol, and have presented a challenging problem since no scheme of analyses has been established for separating these constituents. A separation method has been developed by the Western Utilization Research Branch, and an araban-galactan fraction, an xylan rich fraction, and an alpha cellulose fraction have been isolated. These polysaccharides together with pectin, protein and other insolubles are believed to contribute to the consistency or "body" of products prepared from tomato.

Plans - Investigation of the polysaccharide constituents of different varieties of tomato and study of the properties of the polysaccharides will be continued. Such information should contribute to the solution of tomato processing problems.

Publication

Some Carbohydrate Components of Tomato. Kenneth T. Williams and Arthur Bevenue, Jour. Agri. and Food Chem., 2, 472-4 (1954).

FACTORS THAT DETERMINE TOMATO JUICE CONSISTENCY - EU

Progress and Findings - Last year's report showed that cellulosic material is the main factor which controls the viscosity of tomato juice. Subsequently, cellulosic dispersions of semi-gel consistency have been made of tomato cell walls at a concentration of only 0.4 percent. The attempt has been made to measure the contribution to consistency made by insoluble solids other than cellulose, e.g., proteins and color granules. Classification of cellulosic constituents of juice by sieving was made to test the effect of particle size on consistency. Measurements of the crystallinity of the cellulose from

various hot- and cold-break juices by birefringence and X-ray diffraction were begun. A considerable dependence of the viscosity of cellulosic dispersions on pH and the concentration of electrolyte was noted. The attempt was made to account for the large water-holding power of pectin-free cellulose in terms of associated hydrophilic polymers such as hemicellulose. These experiments are not yet complete. Also begun was an electron microscopic study of the structure of the tomato cell walls, with the expectation that the structural observations may be correlated with data on composition and consistency. Thus far, only isolated cells and cell fragments of pectin-free juices have been examined. It has been found that the cell wall surface is an irregular fabric made up of fibrils about 300 Angstrom units in diameter. Work to be undertaken will be with ultra-thin sections of intact tissue, in order that cell walls may be studied in cross-section.

Plans - More work will be done on the fundamental aspects of this problem, and the study will be expanded to include factors that determine the consistency of tomato juice concentrates.

Publications

Effect of Processing Conditions on the Viscosity of Tomato Juice, by D. B. Hand, J. C. Moyer, J. R. Ransford, J. C. Hening, and R. T. Whittenberger, in press, Food Technology.

QUALITY STUDIES ON PROCESSED TOMATO PRODUCTS - EU

Progress and Findings. The difficulty in obtaining comparable color in tomatoes grown in the eastern and middlewestern regions with that of California grown tomatoes has accounted in part for the decreased commercial tomato acreage in these areas during the last decade. A contract study between the EU and the Maryland State Experiment Station was initiated to improve the color and quality of tomato products prepared from eastern grown tomatoes. During the 1952 season the effect of heat application on the loss of color in tomato juice was established in terms of the U.S.D.A. color scoring system, and time and temperature of heating. Work during the past year has shown that this relationship was valid, within the limits of good commercial practice, for calculating color loss in tomato juice under variable types and temperatures of heating media, container size, and raw stock quality. This study promises to provide much needed information for the improvement of product quality from eastern grown tomatoes. Continued success in this investigation will be helpful to eastern growers and processors. In addition, the consumer will also benefit from the savings accruing from the production and processing of raw material in the region of highest consumption.

Plans - This contract study will be completed upon analysis of the 1954 experimental pack.

Publication

Effect of Application of Heat on Tomato Juice Color, by A. Kramer and A. A. El-Kattan Food Tech., 7, No. 10, pp. 400-404 (1953).

NITROGENOUS CONSTITUENTS OF VEGETABLES - EU

Progress and Findings - Work on the isolation of the various nitrogen constituents of vegetables was continued at the EU. The dry matter of cabbage contains about 15 percent of nitrogenous compounds. Separation of the complex mixture of nitrogen compounds was accomplished by electrodialysis; i.e., selective diffusion through membranes in an electrostatic field. Water-soluble dialyzed nitrogen of cabbage ranged from 57-60 percent of total nitrogen. The cathode fraction contained 47 percent of this total, of which 25 percent was α -amino N and 9.85 percent was ammonia-amide N. Thirteen percent is still unidentified. The anode fraction contained 11 percent of the total N, of which 4.8 percent was α -amino N and 3.9 percent was ammonia-amide N. About 2.4 percent of the N in this fraction remains unidentified. The non-dialyzable N of the center compartment, representing 43 percent of the total N, contains only 2.6 percent α -amino N and 3.1 percent ammonia-amide N. This indicates that this fraction is primarily made up of proteins and polypeptides. The data indicate that 100% of the total N can be consistently recovered in the three fractions, and that 94 percent and 95 percent of the α -amino and ammonia-amide N, respectively, can be accounted for. Nitrate nitrogen represents only 0.8 percent of the total N of cabbage tissue. The various fractions have also been subjected to further study, with the ultimate objective of quantitative characterization of all nitrogen constituents.

Plans - This work will be expanded to include other economically important vegetables.

CHROMATOGRAPHIC DETERMINATION OF SUGARS - WU

Progress and Findings - During the past year, a method has been developed by the WU for the direct and rapid quantitative determination, on the filter paper, of sugars separated by chromatography. This is a substantial improvement over previous methods that required the removal of the sugar from the paper and its subsequent measurement.

This technique is especially useful for measuring sugars not ordinarily included in present methods of analysis, because of the difficulty of the analytical procedures, and will facilitate the investigation of their effect on quality and nutritional values of vegetable products.

Plans - Work is currently under way on the synthesis and microscopic identification of microgram quantities of the 2,4-dinitrophenylhydrazones of certain sugars that have been separated by paper chromatography. The suitability of representative commercial filter papers for making quantitative and qualitative chromatographic separations of sugars and their derivatives will be investigated.

Publication

Crystalline 2,4-Dinitrophenylhydrazones of D-Fructose.
Lawrence M. White and Geraldine E. Secor, J.A.C.S., 75, 6343 (1953).

SUGARS IN SWEETPOTATOES - SU

Progress and Findings - Investigations have been continued at SU on the sugars in sweetpotatoes, with the ultimate objective of determining the effects of changes in these constituents during storage and processing on the texture, flavor, and related properties of derived products. Chromatographic methods reported in the literature have been and are being evaluated in an effort to find a suitable one for separating the individual sugars in the mixture extracted from the sweetpotato. One irrigant has been found that affords excellent separations of at least fourteen reducing materials. Tentatively, two sugar phosphates, two amino-sugars, and five mono- and disaccharides have been located. When duplicate paper chromatograms spotted with the so-called sugar mixture were developed with ninhydrin, at least thirteen spots were found. Five of these are present in substantial quantities and the remainder in smaller concentrations.

Plans - The investigations will be continued to complete the isolation and identification of sugars and associated constituents in a series of sweetpotato samples representing storage of the raw stock at 60° F. from time of harvest through 6 months, and the dehydrated products made from these samples.

Additional work is needed to determine the role of enzymes in starch-sugar transformations in the sweetpotato. (See Proposals for Committee Consideration).

ENZYME SYSTEMS AND BIOCHEMICAL CHANGES IN VEGETABLES - WU

Progress and Findings - 1954 Recommendation "Initiate a comprehensive study of the enzyme systems present in various vegetables and their relationships to the biochemical changes which occur (1) during the interval between harvest and processing, and (2) during storage of underblanched, frozen or dehydrated products." (2/18)

Lack of resources at WU prevented the initiation of a comprehensive study of enzyme systems as recommended; one line of research of limited scope has been continued. Limited investigations on the respiratory enzymes of sweetpotatoes have been initiated at the SU by a shift of resources from other projects.

ENZYMES AFFECTING QUALITY OF CONCENTRATED TOMATO PRODUCTS - WU

Studies on enzymes causing the rapid destruction of pectic substances during processing of tomato paste are continuing at the Pasadena Laboratory.

It has been found that two pectic enzymes are present in tomatoes which, if not rapidly inactivated when the fruit is crushed, destroy the natural pectin. This destruction of pectin was responsible for the low consistencies obtained in tomato products when preheating temperatures employed were too low (below 185°F.), or when elapsed time between crushing and preheating was in excess of 30 to 90 seconds.

Model system studies conducted with purified pectic enzymes isolated from tomatoes, confirm the loss of consistency in tomato products caused by the action of these enzymes. Using a newly developed instrumental method for measuring consistency in tomato pastes, it was demonstrated that the consistencies of commercial, pectin-containing tomato pastes are lowered in a short time by amounts in excess of 50% through the action of tomato pectic enzymes on these products.

Further fundamental studies on the properties and action of these enzymes have led to the development, on a commercial scale, of methods of processing whereby controlled amounts of pectic enzyme action may be introduced during processing. This makes possible the production of tomato pastes of a wide range of consistency characteristics by controlling pectin retention during processing.

Continuing studies at the Pasadena Laboratory on the effect of processing methods on the quality of tomato products have revealed that a flavor similar to the odor of green tomato plants develops in tomato macerate which is not preheated. Preliminary evidence indicates that this flavor change is a slow enzymatic alteration of flavoring constituents which can be prevented by preheating to a temperature of about 140°F. within several minutes of the time of maceration.

Plans - Studies of pectic enzymes and pectic substances in tomatoes as they affect consistency of tomato products are continuing. Work has been initiated to study other enzymatic alterations which affect consistency. Studies on the apparent enzymatic change in flavor which occurs during processing have been initiated with particular emphasis on the identification of the constituents responsible for the characteristic flavor of tomato products. When the constituents responsible for flavor are identified, it will be possible to study more efficiently their enzymatic alteration during processing and the resulting effect on flavor.

RESPIRATORY ENZYMES OF SWEETPOTATOES - SU

Progress and Findings - Investigations have been initiated at SU on the respiratory enzymes of sweetpotatoes and control of their activity to prevent or retard deterioration and enzymatic discoloration of the potatoes during storage, handling, and processing. Preliminary experiments have indicated that the binding of radioactive copper ions to catecholase or the exchanging of radioactive copper ions with the copper of the oxidase are principally dependent on the enzyme being in an oxidizing state, i.e., in a solution containing buffer, enzyme, catechol, and oxygen. The relationships between the rate of binding or exchanging of the radioactive copper ions with the copper of the enzyme and the rate of reaction inactivation are being determined.

Plans - Investigations will continue along the same line over most of the coming year. In new work, the effects of substrates, pH, intermediate products and end-products on the catecholase activity will be investigated to indicate sources of products and possible mechanisms of utilization of the substrates to form colored products.

E. Proposal for Committee Consideration - Expand basic investigations, including the microscopic and submicroscopic structure of plant tissue, to determine the constituents of vegetables of different varieties, at different stages of maturity, and as grown under different seasonal, locality, or other environmental conditions, and the role of these constituents on chemical changes which affect product quality, with particular attention given to the

1. Expansion of study of protein constituents, including procedures for isolating and characterizing the proteins;
2. Expansion of research on role of amylolytic enzymes in carbohydrate transformations in sweetpotatoes during storage, handling, and processing;
3. Initiation of fundamental research on respiratory enzyme systems of sweetpotatoes and their role in undesirable discoloration during storage, handling, and processing;
4. Initiation of research to devise methods of curbing the activity of yeasts in commercial cucumber fermentations, thus eliminating gaseous-type fermentation causing loss by bloaters;
5. Expansion of work on methods of eliminating or inhibiting pectin - and cellulose - destroying enzymes responsible for softening in commercial brining of cucumbers;
6. Expansion of research on the number, identity and properties of predominating molds associated with the growing cucumber plant;
7. Initiation of research on enzymes present in southern peas and their activity in relation to maturity, and time and temperature inactivation by blanching;
8. Initiation of a comprehensive fundamental study of the chemical and physical changes occurring during freezing and thawing of vegetable tissue for the purpose of improving texture of the frozen product.

EFFECT OF INSECTICIDES ON PROCESSING QUALITY OF VEGETABLES - WU

Progress and Findings - 1954 Recommendation "Initiate research to develop more rapid and improved methods for determining the palatability of foods to aid in the evaluation of the quality of vegetables as affected by agricultural chemicals." (3/18)

Studies under way at the Prosser, Washington Laboratory in cooperation with the Washington State Irrigation Experiment Station to determine the effect of new insecticides on suitability of vegetables for processing have been inactive during the past year because of unavailability of vegetables grown under controlled conditions.

Plans - It is planned to continue the investigation at the Prosser Laboratory as samples become available from the Washington State Irrigation Experiment Station.

- F. Proposal for Committee Consideration - Expand investigations on the effect of agricultural chemical residues on flavor and other quality characteristics of processed foods. The importance of this problem to the grower and processor, aside from the public health aspect, is becoming increasingly more evident with the expanding use and rapid development of new insecticides.

See also Proposals for Committee Consideration under Production Research.

PALATABILITY AND AGRICULTURAL CHEMICALS - HN, HC, ENT

Progress and Findings - 1954 Recommendation, "Initiate research to develop more rapid and improved methods for determining the palatability of foods to aid in the evaluation of the quality of vegetables as affected by agricultural chemicals." (3/18)

No funds were available to initiate systematic studies needed for development of improved methods. As in the past, studies of the palatability of foods have been designed insofar as possible to permit some limited evaluation of methods. This year such an opportunity was afforded in studies of the flavor, of squash as affected by agricultural chemicals (coop. Ent.) and of experimental fruit jellies.

Methodical studies. In the study of squash, a comparison was made of two scoring methods: (1) Paired samples (one treated and one untreated) presented in a given order with instructions to taste a certain sample first but with no restrictions on retasting; and (2) four samples (one treated and three untreated) presented one at a time with 3-minute intervals between samples and no re-tasting permitted. In the second method, a known reference sample was

provided for use as a standard throughout the tasting session. In the first method the sample was served as slices while in the second it was mashed to obtain greater homogeneity. There were two rating sessions in each case and judges scored intensity of off-flavor and general acceptability. A considerably larger experiment would be required for definite proof as to the superiority of either the method employing a reference standard or the paired scoring method used in the squash test.

In the studies of jellies, two methods of testing, ranking and scoring, and two types of panels one comprised of five trained members and the other of 40 untrained members were compared. To determine whether differences in flavor of fruit jellies made with varying proportions of sugar to juice could be discriminated by taste, jellies varying in the amount of natural fruit flavor present were made, using proportions ranging from equal amounts to twice as much sugar as juice but having 62 percent soluble solids in the finished jelly. These were taste-tested by 40 untrained persons. In a triangle test, 26 of the people could distinguish between two samples having the largest difference. More people preferred the smaller proportion of sugar to juice. When the choice was between the medium and small proportions of sugar to juice, a larger number of people preferred the medium proportion. A trained panel of five persons rated jellies with the same high, medium, and low proportions of sugar to juice on a 5-point scale for amount of natural fruit flavor. Mean scores ranged from 2.8 to 3.1 showing that they could detect little difference in the amount of natural fruit flavor in these samples. The variation in results from the two panels may be due to the difference in the methods used for evaluating flavor. The triangle test indicates only whether there is any difference between samples; while the scoring method attempts to measure the degree of difference.

Problems experienced by the panel members in evaluating differences in flavor of jellies led to another experiment on methodology of taste-testing. Samples of jelly were prepared from concentrated frozen grape juice diluted with different amounts of water so that the jellies differed in amount of grape flavor. Samples were presented in various ways and in varying numbers per session, and rating was done by ranking and by scoring. The differences among the samples were large enough that all members of the tasting panel could differentiate the samples by either the ranking or scoring method.

Plans - Limited methodological studies as described will be continued until funds become available to undertake systematic research on improved methods of evaluation of palatability applicable to fruits and nuts. See proposal for Committee consideration.

Flavor Testing of Vegetables - As in studies made in previous years, soil or foliage applications of benzene hexachloride (BHC) and its insecticidal gamma isomer have frequently been associated with characteristic off-flavors in vegetable crops while treatments with other insecticides have not been generally followed by significant flavor defects.

Off-flavors were observed in canned mushrooms and cream of mushroom soup prepared from mushrooms harvested three days after the last of a series of three applications of lindane to the beds. The flavor defect was more obvious in the canned mushroom pieces than in the soup. With the latter, the off-flavor was obvious only when it was made from mushrooms harvested from beds treated with one pound per acre of lindane. In the canned mushroom pieces, the flavor defect was evident following treatments of $1/4$, $1/2$ or 1 pound per acre. No off-flavors were observed in these products when prepared from mushrooms harvested 14 days later from the same beds.

New studies have provided additional information on flavor defects in vegetables caused by soil residues of BHC applied to preceding crops. Turnips, which were not treated directly with insecticide, were found to have off-flavors that seriously impaired their eating quality when produced in soils used during the preceding four years for a series of 13 crops, 11 of which were treated with technical BHC, purified gamma BHC, or commercial lindane to provide cumulative plot dosages of these insecticides of 95 or 190 pounds per acre. Very strong off-flavors were found in carrots produced without direct insecticide treatment in soils used during the preceding three years for seven different crops to which a total of 100 pounds per acre of technical BHC had been applied. No off-flavors were observed when the preceding crops received total applications of 100 pounds per acre of CS-708 or 50 of isodrin.

Other studies indicate that summer squash are less likely to develop off-flavors following treatment with lindane (purified gamma BHC) than are many other vegetables that have been tested. Indications of minor off-flavors were found in some samples of scallop, yellow straightneck and Zucchini squash harvested either one or three days after treatment of the plants with a series of 35-pound per acre, applications of lindane dust providing total applications of 140 to 210 pounds per acre of insecticide. The flavor defects noted were generally so minor, however, that any serious impairment of the eating quality of the squash was considered questionable.

Plans - Upon request, available funds will continue to be used to conduct palatability studies on foods in relation to treatment with insecticides or other agricultural chemicals in cooperation with Departmental Research Agencies that are concerned with the development, use, mode of application, and control of agricultural chemicals in food crop production or food processing and storage.

- G. Proposals for Committee Consideration - Expand studies to develop improved laboratory methods and procedures for determining the quality characteristics influencing palatability and generally associated with consumer acceptance of food. Emphasis should be given to devising and standardizing methods for the sensory evaluation of food quality and to developing more rapid and precise methods for determining palatability of foods. Basic physiological, psychological, biochemical, and electro-chemical reactions involved in sensory methods of evaluating food quality should be investigated in order to understand better the mechanisms involved. Supplementing sensory evaluation of such quality factors as color, flavor, and texture parallel research should be undertaken to develop and standardize selected objective methods of measuring the physical, chemical, and histological attributes of foods. Also new and improved experimental designs and statistical procedures would be developed.

Publications

Quality and yield of filbert nut meats as affected by time of insect attack and use of certain insecticides by Gladys L. Gilpin, and Elsie H. Dawson, Bureau of Human Nutrition and Home Economics, and E. H. Siegler, Bureau of Entomology and Plant Quarantine. Food Technology 7 (8): 329-331, 1953.

Effect of benzene hexachloride sprays on the flavor of fresh, frozen and canned peaches, Gladys L. Gilpin and Elsie H. Dawson, Human Nutrition Research Branch, and E. H. Siegler, Entomology Research Branch. Journal of Agricultural and Food Chemistry, 2 (15): 781-783, July 21, 1954.

Flavor of peanut butter as affected by aldrin, chlordane, dieldrin, heptachlor, and toxaphene used as insecticides in growing peanuts, Gladys L. Gilpin, Ruth A. Redstrom, and Howard Reynolds, Human Nutrition Research Branch, and Fred W. Poos, Entomology Research Branch. Journal of Agricultural and Food Chemistry, 2 (15): 778-780, July 21, 1954.

Benzene hexachloride content and flavor of peanuts grown in rotation with cotton dusted with this insecticide, Irwin Hornstein, Entomology Research Branch, and Howard Reynolds and Gladys L. Gilpin, Human Nutrition Research Branch. Journal of Agricultural and Food Chemistry, 2 (15): 776-778, July 21, 1954.

OBJECTIVE MEASUREMENT OF QUALITY FACTORS - WU

Progress and Findings - 1954 Recommendation "Expand studies leading to the development of new or improved methods and instruments for the objective measurement of quality factors in raw and processed vegetables." (4/18)

NEW INSTRUMENTAL METHODS FOR MEASURING CONSISTENCY IN FOOD PUREES AND PASTES - WU

Adaptation of a new instrumental method for measuring consistency in tomato pastes, purees and catsups has been completed at the Pasadena Laboratory. Although developed primarily for use on tomato products, the method should work equally well on other types of food purees and pastes. Results of two years' testing under laboratory and plant conditions have indicated that this instrumental method is well suited to consistency measurements and largely overcomes the drawbacks of previous methods caused by the heterogeneous nature of the materials studied. The excellent results have led to the early adoption of the method by many tomato processing companies and other organizations serving the food industries.

Plans - The new method of consistency measurement will be applied and further evaluated in continuing studies on enzymatic and chemical changes during processing which affect consistency and other quality factors in tomato products.

Publications

"Measurement of Food Characteristics. Application of Potentiometric Rotary Viscometer to Measuring Consistency of Food Purees and Pastes," R. J. McColloch and E. A. Beavens, Agric. & Food Chem., 2, 986 (1954).

QUALITY OF FROZEN LIMA BEANS - WU

Progress and Findings - A research contract has been negotiated between WU and the Utah Agricultural Experiment Station to study the relationship between raw material maturity of lima beans and processed product quality with the object of improving methods of raw material selection, particularly in the newer all-green varieties. Methods of maturity estimation include reflectance color, total solids and alcohol-insoluble solids. Quality of the processed products will be determined by objective tests and organoleptic evaluation.

The introduction of the all-green varieties of lima beans has complicated considerably the use of color, as previously employed, as an index of maturity. With the older varieties, the percentage of white beans present served as an indication of the degree of development of the material. The white beans, which were undesirable in top quality processed products, were removed by sorting. The all-green varieties do not afford such advantages since they remain green at all stages of development. Thus, new methods of estimating maturity must be developed for the all-green strains.

Plans - The contract calls for these studies to be conducted for two growing seasons.

SUITABILITY OF VEGETABLE VARIETIES FOR PROCESSING - WU

Progress and Findings - Green bean variety testing studies were continued at the Puyallup Laboratory of the WU in cooperation with the Western Washington Experiment Station. In previous years commercial varieties of bush and pole beans have been grown and processed to determine their suitability for this area. Certain methods for measuring quality factors have been used and tested on these commercial varieties. Such measurements as tough string count, fiber content, color on fresh and processed beans, and the straightness index have been found useful in evaluating quality. Now these techniques will be applied in testing new hybrids of beans that are being selected in the plant breeding program at this station. This year nine hybrids of wax and green pole beans were selected for processing studies. These and others that appear promising in seasons to come will be tested as the plant breeding program progresses.

Ten hybrid selections of corn from the plant breeding plots at this Experiment Station were available for processing tests this year. There are a number of well known objective methods for measuring maturity and quality of corn. These methods, together with subjective appraisal of the processed product, will be used to assist in selecting the most desirable corn for processing purposes. A method for estimating texture of corn is being investigated, which, if found to give reproducible results, may be another useful tool in evaluating quality of corn.

Plans - Work on evaluating the processing qualities of vegetables will be continued in cooperation with the plant breeding program at the Western Washington Experiment Station.

DETERMINATION OF MOISTURE IN VEGETABLES - WU

Progress and Findings - Development work on a new method for determining moisture in vegetables based on magnetic properties of the hydrogen nucleus, has been continued by WU. Tests on powders and other non-homogenous samples are limited to a volume of 0.6cc in the present equipment. Efforts to increase the volume of sample that can be accommodated and thus allow use of more representative samples have not been successful. For homogenous samples, however, satisfactory performance has been obtained on samples as large as 15cc. Means have been devised to calibrate the magnetic absorption apparatus in terms of a single standard substance (water) and thus to eliminate the need for individual calibration on various types of vegetable tissue to be tested. The use of water as a reference standard is a significant advance in the development of a procedure for determination of moisture in vegetable materials on an absolute basis. This development, together with a new method which has been devised for continuous standardization of the absorption instrument, are essential steps in the application of the new method on an industrial rather than a laboratory basis.

Plans - Future work on the method is to be devoted primarily toward simplification of instrumentation with a view to industrial application.

Publications

"Moisture Determination of Foods by Hydrogen Nuclei Magnetic Resonance." T. M. Shaw, R. H. Elsken and C. H. Kunsman, Jour. AOAC 36, 1070 (1953).

"Quantitative Measurement of Magnetic Absorption Utilization a Null-Balance System." R. H. Elsken and T. M. Shaw, Physical Review, 93, 943A (1954).

PHOTOELECTRIC MEASUREMENT OF COLOR AND MATURITY IN SWEET CORN - WU

Progress and Findings - Work has been continued by WU on the relationship between color and maturity to determine the possible usefulness of color as an index of maturity for freezing and canning.

A contract with the Utah State Agricultural Experiment Station dealing with this problem has been signed during the past year. In this project, five commercial varieties of sweet corn will be grown during two growing seasons under optimum conditions of irrigation and fertilization. Harvests are to be made at five levels of maturity to give the desired range of raw material quality. Correlation of the results of analytical examination with those of taste panel appraisal showed that moisture contents, alcohol-insoluble solids, succulometer values (volume of expressed juice) and soluble solids were satisfactory for indicating maturity.

Color measurements were made on the raw and blanched samples. However, color alone was not considered a good index of maturity, even though a trend from yellow to orange was observed as the corn matured, because of considerable fluctuation in color readings on different areas of each ear. This varied over a wider range than the average of these measurements between adjacent maturity levels.

As the moisture content has been generally used to indicate quality in raw corn, an effort has been made to establish the relations between moisture and color factors. An experimental photoelectric photometer was developed at the Western Regional Research Laboratory to measure color attributes in a way that might lend itself to rapid automatic sorting operations. The color measurements obtained on raw corn with this new instrument give as good agreement with percent moisture as those obtained with the two existing commercial instruments. However, the working range of the new instrument has been improved, and has resulted in better sensitivity for selecting corn samples in the range of more advanced maturity.

Plans - It is planned to complete this investigation during the current year.

Publication -

"Color-Moisture Relations of Yellow Sweet Corn." H. C. Lukens, R. P. MacKenzie, and C. H. Kunsman, Jour. A.O.A.C., 37, No. 2, 489-99 (1954).

- H. Proposal for Committee Consideration - Expand studies leading to the development of new or improved methods and instruments for the objective measurement of quality factors in raw and processed vegetables. Chemical tests or instruments which could supplement the judgment of experienced field men would make it easier to determine when the proper maturity of a crop has been reached and when a given field should be harvested in order to assure the greatest return to the

farmer and the processor and the best quality product to the consumer. Presently available methods are either too laborious and time consuming and/or require elaborate equipment, or are not sufficiently reliable to warrant practical application. Reliable, readily usable and reproducible objective methods, such as might be based upon color, moisture, tenderness, etc. for measuring quality would aid materially in the development of improved processing methods and would result in greater uniformity of product and improve inspection practices by minimizing the human element in grading. The establishment of instrumental methods for measuring quality of different vegetables would in many cases make possible the development of automatic sorting equipment which would reduce inspection line costs and insure more accurate separation of product into appropriate grades.

NUTRIENT IN VEGETABLES - HN

Progress and Findings - 1954 Recommendation "Initiate research to determine in vegetables the content of important nutrients including carbohydrates and newly identified nutrients and determining the effect of common methods of household processing upon such values."
(5/18)

Funds provided for expansion in fiscal year 1955 are being used to initiate cross commodity studies of vitamin B₁₂ and of minerals in foods. Of the 57 mineral elements reported in foods, special attention is to be given first to potassium, magnesium, cobalt, copper, and manganese because fairly satisfactory methods are presently available. The calcium and phosphorus content of newer types and forms of foods on which data are lacking will be determined. Later attention will also be given to molybdenum, strontium, and selenium. Funds were not sufficient to initiate a study of carbohydrate fractions in foods. See proposal for Committee consideration.

Studies of content of amino acids, fatty acids, crude fiber and pantothenic acid in foods have been continued under previously available funds. Pantothenic acid values of over 200 foods, including over 40 vegetables, have been completed and results are being prepared for publication. The majority of vegetables were found to have pantothenic acid values of 2 to 5 gamma per gram of fresh weight, but a few, including Brussels sprouts, green peas, sweetpotatoes, acorn squash, and mushrooms, were found to be good sources (more than 5 gamma per gram) of this B-vitamin. Microbiological methods for the determination of cystine and tyrosine have been developed during the year. The content of these two amino acids in fresh peas and lima beans along with more than 80 other foods have been determined.

Completed this year under contract has been an annotated bibliography and compilation of data on fatty acid content of commodities from 922 research reports published 1920 to 1950. The compilation was undertaken to indicate the relative value of different foods as sources of unsaturated fatty acids and to contribute to tables for estimating the fatty acid content of diets in this country. Many gaps in the information currently available was apparent from this compilation. Only about 25 percent of the reports pertain to foods and many of the values are tentative because of unsatisfactory methods or because analysis did not include all the important fatty acids. About 30 of the 922 reports dealt with the fatty acid composition of vegetables.

Plans - Results of the pantothenic acid, fatty acid, and amino acid analyses of foods will be prepared for publication. Studies of "non-essential" amino acid content of foods will be continued. As the pantothenic acid studies are completed, the unit will direct attention to determination of the pyridoxine (another B-vitamin) in foods.

- I. Proposal for Committee Consideration - Expand nutritive value analyses to determine the content of important nutrients in foods as commonly processed and eaten. Rapid changes in commercial processing of vegetables, and consequent changes in the type and extent of kitchen preparation required, is rendering obsolete many nutritive value figures now contained in tables of food composition. Data on carbohydrate content are now very unsatisfactory because of inaccuracies of older methods; the American Diabetic Association is urgently requesting more reliable data on the starch, sugar, fiber and other carbohydrate content of foods as eaten. Dependable data on all nutrients are needed by nutritionists, dietitians and others responsible for food planning, particularly in controlled diets where content of calories, carbohydrates, sodium, or other constituents must be restricted precisely or content of some nutrients enhances.

Publications

"Availability of amino acids to microorganisms. II. A rapid microbial method of determining protein value," Journal of Nutrition, 52, 375-381, March 1954. Horn, Millard J., Blum, Amos E., and Womack, Madelyn.

"Microbiological procedure for the assay of pantothenic acids in foods: Results compared with those by bioassay," by E. W. Toepfer, E. G. Zook, and L. R. Richardson. J. of Assoc. of Official Chemists, Vol. 37, pp. 182-190, February 1954.

"Fatty Acid Content of Several Food Products," by C. Willard, R. D. Engler, and L. M. Richards. Jour. Am. Oil Chemists Soc., Vol. 31, Nov. 4, April 1954, p. 135.

"Energy Value of Foods -- basis and derivation," Agr. Handbook 74. 1954.

SURVEY OF FOOD AND NUTRITION RESEARCH - HN, DU

Progress and Findings - To aid research leaders in universities, industry, and government prevent duplication of effort, a survey on the nature and amount of food and nutrition research under way in this country during 1952-53 was completed under contract by the National Academy of Science. The report records research under way by some 440 organization. It includes research in foods, food technology, physiological and biochemical aspects of nutrition, nutrition in disease, the nutritive value of food and feed and nutritional requirements of man and beast. More than 200 of the research projects listed deal with vegetables and vegetable products. Included in the areas of work under investigation are studies of the composition and nutritive value of vegetables, plant nutrition, effects of pesticides on composition and quality, engineering methods and equipment for handling and processing, processing and storage, marketing and packaging. Also included in the report are some 250 suggestions for research of immediate urgency.

Plans - This project has been completed.

Publications

Survey of Food and Nutrition Research in the United States of America 1952-53. U. S. Department of Agriculture, April 1954.

PRESERVATION OF COMMERCIALY BRINED CUCUMBERS - SU

Progress and Findings - 1954 Recommendations, "Expand research to devise methods of curbing the activity of yeasts in commercial cucumber fermentations and of thus eliminating the gaseous-type fermentation causing bloaters." (9/18)

"Expand research on the populations, identity, and biochemical properties of the predominating molds (higher fungi) associated with the growing cucumber plant." (10/18)

Investigations to determine the nature and origin of the chemical agents (enzymes) in cucumber brines that are responsible for spoilage by softening and to develop measures of control have been continued at the U. S. Food Fermentation Laboratory, Raleigh, N. C., in cooperation with the N. C. Agricultural Experiment Station.

In last year's Progress Report it was pointed out that rather high mold populations are built up in the growing cucumber plant (flowers, ovaries and fruit) during the harvest season. These molds are believed to be the source of the softening enzymes (pectinase and cellulase). Hence, it appears that the actual mode of enzyme introduction is, for the most part, by way of the partially dried, heavily mold-laden, cucumber flowers that remain attached to cucumber fruit. An endeavor is being made this year to demonstrate conclusively that the above concept is true. Once this is definitely established the cucumber pickle industry may reduce losses caused by softening in the brining vats by eliminating most, if not all, the flowers at the time of brining. Currently, the cellulolytic and pectinolytic activities of isolated identified molds are being investigated. During this last harvest season (June-July) numerous experimental vats and barrels (pilot-plant scale investigations in a commercial plant) received treatments designed to give information on: (a) the influence of retained flowers from the cucumbers from early, middle, and late harvest on the firmness of brine-cured stock; (b) the influence of different levels (0 to 100% retention) of added cucumber flowers on softening of cucumber brine-stock; (c) the influence of the addition of sorbic acid to cucumber fermentations in controlling the gaseous fermentation and subsequent bloater formation (hollow stock); and (d) brine extraction of the softening enzymes (cellulase and pectinase) from cucumber flowers and testing such flower extracts as to their ability to soften cucumbers brined according to regular plant procedure. Since the above indicated laboratory and field experiments are still in progress at the time of the preparation of this Progress Report, no data are yet available for evaluation.

Plans - Unless this season's research findings point to more important projects, efforts in 1955 will be devoted to work in the fields covered by the two 1954 Recommendations listed above. (See Proposals for Committee Consideration).

Publications

A Procedure for Demonstrating the Presence of Carotenoid Pigments in Yeasts. W. J. Peterson, T. A. Bell, J. L. Etchells, and W. W. G. Smart, Jr. J. Bact., 67(6): 708-713. June 1954.

Varietal Differences in Cucumbers for Pickling. I. D. Jones, J. L. Etchells, and R. J. Monroe. Food Technol., 8(9): 415-418. Sept. 1954.

Control of Molds During the Enumeration and Isolation of Yeasts from Soil and Plant Materials. J. L. Etchells, R. N. Costilow, T. A. Bell, and A. L. Demain. Applied Microbiology 2(5): 296-300. Sept. 1954.

ANTIBIOTICS IN FOOD PRESERVATION - WU

Progress and Findings - 1954 Recommendation "Expand current studies on the use of antibiotics in Food preservation." (14/18)

Limitations of funds prevented expansion.

Investigation of the mode of action of antibiotics on spores of microorganisms has been continued by WU in order to understand the mechanism whereby spoilage organisms are killed, thus enabling more rapid progress in the development of better methods for vegetable preservation. Substantial progress has been made toward solution of one of the troublesome problems in this investigation, e.e., determining whether spores have actually been killed or whether prolonged periods of dormancy have been induced in the spores by a given treatment. This new knowledge resulted from the observation that a strain of Bacillus subtilis will adsorb sufficient of the antibiotic subtilin to kill the spores at the time of germination. If, however, prior to germination, the spores are treated with trypsin (a protein-digesting enzyme), the adsorbed subtilin (a protein-like material) is inactivated, and the spores will grow.

The use of trypsin makes it possible for the first time to determine the true number of viable spores in a sample where appreciable concentrations of subtilin are adsorbed on the spores. Thus, it has been demonstrated convincingly that, with a number of Bacillus species, the entire spore population is killed by subtilin upon germination. However, with one strain of Bacillus macerans, germination of some of the spores was prevented by subtilin. In this case, subtilin exerts a sporostatic rather than sporocidal action.

Screening tests in progress, under contract with Washington State College to find more effective antibiotics for use in vegetable processing, have been practically completed. No antibiotic was found that was more effective than subtilin although nisin was found to be equally effective under certain conditions. Screening of 27 additional agents showed none to be more active than subtilin but it did reveal three (aureolic acid, hygromycin, and N-butylsulfinat) with activities approaching that of subtilin. Some other agents reported elsewhere as having activity were found to be ineffective under conditions of the test.

Plans - Investigation of the mode of action of subtilin (and other agents) will be continued and basic information concerning heat resistance of bacterial spores will be sought to aid in the development of more effective methods of spore destruction.

Publications

"Antibiotics in Food Processing Additives Accelerating Death of Spores by Moist Heat." J. C. Lewis, H. D. Michener, R. R. Stumbo and D. S. Titus, Jour. Agric. and Food Chem. 2 (6), 298-302 (1954)

"The Bactericidal Action of Subtilin on Bacillus Stearotherophilus," H. D. Michener, Applied Microbiology 1 (5), 215-217 (1953).

"Observations on the Morphogenesis of Arthrobacter Citreus, Spec. Nov." L. E. Sacks, Jour. Bact. 67, 342-345 (1954).

"Use of Organic Solvents in Cylinder-Plate Assays." Neva Snell, Applied Microbiology 2 (3), 174-175 (1954).

- J. Proposal for Committee Consideration - Expand investigations on the use of antibiotics (or other agents) in food preservation and on factors affecting heat resistance of spores of spoilage bacteria as a basis for improvements in vegetable canning methods. Fundamental knowledge of the mode of action of antibiotics and how such action can be enhanced in combination with other factors, particularly mild heat treatment, must be acquired in order to provide a sound basis for subsequent practical processing developments in canning. It is also necessary to obtain an understanding of the basic reasons for the resistance of spores to heat in order to develop methods for the control of bacterial spoilage which will minimize requirements for heating.

DEVELOPMENT OF NEW AND IMPROVED PRODUCTS, PROCESSES AND EQUIPMENT

STERILIZATION BY HIGH-SPEED ELECTRONS AND GAMMA RAYS - WU

Progress and Findings - 1954 Recommendation "Initiate research on the electromagnetic radiation sterilization of vegetables and vegetable products by means of contracts placed with institutions which possess the necessary highly specialized radiation-generating equipment." (6/18)

Lack of resources prevented initiation of this work. As mentioned in last year's report, work has been undertaken under a contract with the Massachusetts Institute of Technology, supervised by the WU, to investigate possibilities for sterilizing liquid, frozen and dried egg

products by means of high-speed electrons. Although the results of this work will not be directly applicable to vegetables, it is expected they will aid in providing a basis of extension of this line of investigation to vegetables at such time when funds become available.

- K. Proposal for Committee Consideration - Initiate research on the treatment of vegetable products with ionizing radiations either alone or in combination with heat, freezing, antibiotics and/or other treatments, for the purpose of improving quality and increasing stability, and study the effects of such radiations on the chemical composition, and texture of vegetable products.

TIME-TEMPERATURE TOLERANCE OF FROZEN VEGETABLES - WU

Progress and Findings - 1954 Recommendation "Expand investigation of the refrigeration requirements in each of the several successive stages encountered in the commercial distribution of frozen vegetables to include cauliflower, broccoli, lima beans, spinach, and other vegetables." (7/18)

No expansion was possible because of limited resources.

Studies of effects on frozen vegetables of temperatures and times encountered in commercial transportation distribution, similar to those under way on frozen fruits, have been continued by WU. Samples of commercially frozen peas and beans are being subjected to constant and cyclic temperature conditions over varying periods of time. Included among these are patterns of temperature change similar to those which actually occur in commercial storage and distribution.

Time-temperature studies on all samples obtained during the 1952 processing season and for certain of the 1953 samples, have now been completed. Products included were vined-at-the-plant peas, Dark Seeded Perfection variety, packed in eastern Oregon; pole beans of the Blue Lake variety packed in Oregon; and bush beans, Topcrop variety, packed in New Jersey. The effects of temperature cycles simulating conditions encountered in break-up rooms and retail distribution on the 1952 samples were reported last year. Results of a study on the effects of simulated warehousing conditions on these samples are presented in this report. Temperatures used were -10° , 0° , 10°F. , a fluctuating cycle from -10° to 10°F. with a frequency of one cycle per every 24-hour period, and -20°F. for control samples. Samples were held over a period of one year and were examined at intervals of 2, 4, 8 and 12 months. Subjective evaluations of cooked

samples were made at each holding interval. The factors considered for peas were color, flavor and skin texture, and for green beans were color and flavor. Objective measurements were made on raw samples after 2, 4 and 12 months. These included the determination of ascorbic acid content, conversion of chlorophyll and characterization of color changes.

Frozen peas kept at 10°F., the highest temperature used in the study of simulated warehousing conditions, showed changes in flavor and texture after 2 months and in color after 4 months. Samples held under fluctuating conditions (-10° to 10°F.) showed a significant flavor change after 8 months. After 12 months, samples held at 0°, -10° to 10°F. were significantly different from the control material held at -20°F. in all factors considered. Samples held at -10°F. showed no significant change during this period. Significant loss of ascorbic acid was noted after 4 and 12 months at 10°F. and a significant color change after 12 months at the same temperature. Subjective color changes correlated with chlorophyll conversion.

The 1953 samples of frozen peas were of the same varieties and were procured from the same source as the 1952 samples in order to take into account possible yearly or seasonal variations. Temperatures of holding time included all of the variables used previously and two new variables, namely, 15°F. and a fluctuating cycle from 0° to 20°F. with a frequency of 3 days. Samples were withdrawn as early as 3 days in order to ascertain the first detectable differences between samples held under the different environments.

Peas kept at 30°F. showed significant changes after 5 days while those held at 20°F. showed similar changes after 4 weeks. At the same time intervals, the ascorbic acid loss was about 25 percent but the conversion of chlorophyll was relatively small. Fluctuating temperature cycles from 10° to 30°F. produced objective changes similar to those observed in samples held at 25°F. although changes in flavor appeared sooner in the samples held under fluctuating temperatures than in those held at 25°F. in which first changes were noted after 3 weeks. During this interval ascorbic acid losses ranging from 40 to 50 percent and chlorophyll conversions from 7 to 11 percent were observed. The amount of deterioration brought about by fluctuations from 15° to 25°F. fell between those produced at constant temperatures at 20° and 25°F. Off-flavor development during the holding time was more rapid in the 1953 samples than for the 1952 samples. This may have been due at least in part to a difference in maturity between the peas collected in the two different years.

As reported last year, frozen green beans were found to be fairly susceptible to change when held at temperatures often encountered in retail distribution. Results for 1953 samples of bush beans showed flavor changes occurring rapidly at the higher temperatures - within 3 days at 30°F., 7 days at 10° to 30°F. fluctuating, 2 weeks at 25°F., 4 weeks at 20°F. and at 15° to 25°F. fluctuating, and 6 weeks at 0° to 20°F. fluctuating. Visual color changes also took place rapidly in the samples. In the case of pole beans, held under the above conditions, flavor changes followed the same general pattern but occurred at a slower rate than was the case with bush beans. Visual color changes, however, occurred somewhat more rapidly. Ascorbic acid losses were 50 percent in 2 to 4 weeks, depending on temperature, as compared with a period of 1 to 3 weeks for pole beans. Fluctuating temperatures caused a more rapid deterioration than holding at constant temperature at the mid-point of the cycle.

Plans - Experiments in which samples are being held for as long as 12 months at temperatures of 10°F. and below are still in progress. Additional samples of peas and green beans have been collected from different producing areas during the 1954 processing season for further investigation of time-temperature relationships. In addition, samples of spinach will be collected this year for inclusion in the program as a third vegetable, in order to develop information related to leafy-type vegetables.

- L. Proposal for Committee Consideration - Expand studies on time-temperature tolerance and stability of frozen vegetable products in order to provide a sound basis for guiding process development so that products may be made more stable to the variable temperature conditions encountered in handling subsequent to processing, and to supply the necessary information for the establishment of a sound schedule for the distribution of frozen vegetable products in general. Current studies on enzymatic and non-enzymatic changes affecting color, flavor and stability of frozen vegetables should be intensified. Time-temperature investigations should be expanded to include many frozen vegetables not included in studies to date, such as broccoli, lima beans, and sweet corn, so as to assure greater utilization of these commodities.

CHEMICAL FACTORS ASSOCIATED WITH DISEASE RESISTANCE IN PLANTS - EU

Progress and Findings - 1954 Recommendation, "Initiate an investigation of chemical and biochemical factors in plants that may be responsible for disease resistance and/or susceptibility." (8/18).

Resources did not permit initiation of work.

Plans - Problems associated with this type of work have been discussed with other members of the Agricultural Research Service and with State Experiment Station personnel. The fact that current research programs have not solved the plant disease problem appears to be further justification for a new or different approach. If additional funds and space become available, the recruitment of highly specialized personnel will be initiated and the program started, provided adequate cooperation can be established with other groups in the Department or State Experiment Stations.

NEW VEGETABLE FOOD PRODUCTS - EU

Progress and Findings - 1954 Recommendation, "Expand research on methods for preparing concentrated and dehydrofrozen vegetable products of improved quality, stability, and convenience of use to additional vegetable commodities." (11/18) Available resources did not permit expansion except for a somewhat increased effort on the preparation of tomato juice powder made possible by an internal change of program at WU.

Experimental and developmental work at the Eastern Utilization Research Branch on new pre-cooked, dehydrated vegetable products, analogous to potato chips, was continued in order to provide new outlets for vegetables in the form of snack items, ready-to-serve foods, and soup powders. Optimum cooking times and temperatures in stabilized oils were determined for carrots, beets, parsnips, peas, and lima beans. The following varieties yielded the best products with respect to color and flavor retention: Carrots (Imperator), beets (Early Wonder and Detroit Red), peas (Glacier and Rainier), lima beans (Fordhook), and parsnips (Pennsylvania Guernsey). In general, over-maturity was a prerequisite for good vegetable chip production. Vegetable chips prepared in purified coconut oil were quite stable for three to six months at room temperature and the six months old products could be returned to organoleptic qualities closely approximating the freshly prepared chips by rewarming for short periods. Peas cooked in coconut oil stabilized with small amounts of a mixture comprising butylated hydroxy anisole, propyl gallate and citric acid in propylene glycol were stable for 9-12 months at room temperature. Vegetable chips prepared in purified coconut oil stabilized with small amounts of a mixture comprising butylated hydroxyanisole, propyl gallate and citric acid in propylene glycol were stable for

at least six months at room temperature. These new products were brought to the attention of numerous food processing companies including General Foods, H. J. Heinz Company, Seabrook Farms, Thomas J. Lipton, Inc., and Bell Brand Foods. Approximately 500 individuals in consumer type panels have also evaluated the vegetable chips. Although the general response has been favorable, the commercial development of these products has, to the best of our knowledge, not as yet been undertaken by any commercial group.

Plans - The technical phases of this study have been completed. Future work will be limited to the preparation of samples for interested parties.

VARIETY OF RAW STOCK ON THE PROPERTIES OF DEHYDRATED SWEETPOTATOES -SU

Progress and Findings - Investigations on dehydrated sweetpotatoes were continued at the Southern Utilization Research Branch, in cooperation with the Louisiana Agricultural Experiment Station and the Quarter-master Food and Container Institute, to determine the effects of variety of the raw stock on the chemical composition, stability, rehydration, and acceptability of the dehydrated products. Sweetpotatoes of the Unit I Porto Rico, Goldrush (L-241), Earlyport (L-240), and Maryland Golden varieties were harvested in the fall of 1953 and stored by the Louisiana Station at 60°F. The Experiment Station analyzed the raw materials for shrinkage, total and reducing sugars, carotene, and ascorbic acid. Sample lots were dehydrated at the Southern Laboratory immediately after harvest, after curing, and after storage for 1, 3, and 5 months. The dry products were analyzed for starch, total and reducing sugars, ascorbic acid, and extractable color; and samples were submitted to the QMFCI for evaluation in respect to stability, rehydration, and acceptability.

The comparative chemical composition before and after processing did not indicate any appreciable superiority among the yellow, moist-type varieties. If a dehydrated product having the highest carotene content is desired, the Goldrush variety is definitely superior to the others; but a slightly greater quantity of raw stock is required to produce a given weight of dry product than for the other varieties. The results of the evaluation tests under way at the QMFCI may indicate the superiority of one particular variety.

Plans - The Southern Laboratory's phase of the investigations has been completed and the project is being terminated. Data are being evaluated for publication.

PREHEATING AND DEHYDRATING CONDITIONS ON THE PROPERTIES OF
DEHYDRATED SWEETPOTATOES - SU

Progress and Findings - Another phase of investigations on dehydrated sweetpotatoes at the Southern Utilization Research Branch, in cooperation with the Quartermaster Food and Container Institute, sought to determine the effects of varied conditions of preheating and dehydration on the chemical composition, stability, rehydration, and acceptability of the dehydrated products. The conditions of preheating were: -- (1) None, (2) 130° - 140° F. for 30-40 minutes, and (3) 165° F. for 20 minutes. In one schedule of dehydration, the prepared material was dried for 3 hours at 200° F. dry bulb and 120° F. wet bulb, followed by 1 - 1/2 hours at 160° F. dry bulb, 100° F. wet bulb. In the other two schedules the material was dried at 175° F. dry bulb, and 160° F. dry bulb, respectively, for time sufficient to reduce the moisture content of the product to 4.5 - 5.5 percent. The raw stock and dehydrated products were analyzed for starch, total and reducing sugars, carotene, ascorbic acid, and, in the case of the dry products, extractable color. Samples of the dehydrated products were submitted to the QMFCI for evaluation as to stability, rehydration, and acceptability.

As far as indicated by chemical composition, no single combination of preheating and dehydrating conditions was materially superior to any other combination. The results of evaluation tests under way at the QMFCI may indicate advantages for some combination of the processing conditions.

Plans - The Southern Laboratory's phase of the investigations has been completed and the project is being terminated. Data are being evaluated for publication.

STABILITY OF DEHYDRATED SWEETPOTATOES - WU

Progress and Findings - Results for the Unit I Puerto Rico variety of sweetpotato which indicated that sulfite treatment, dehydration to a low moisture, and packaging in an inert atmosphere were desirable for producing a stable dehydrated product, were reported last year. Samples of the Goldrush variety, processed in the same manner as the Unit I Puerto Rico variety, exhibited relatively poor stability at elevated temperatures. The strong scorched flavor and odor in the cooked samples after 6 months at 100° F. correlated well with the extensive browning that took place. Low moisture was the most important factor in retarding browning, while sulfiting was an important secondary aid particularly at higher moisture levels. The marked inferiority of the Goldrush variety in stability is attributed, at least in part, to a higher sugar content which contributed to more extensive browning.

Plans - Work on the stability of dehydrated sweetpotatoes in relation to processing variations prior to drying has been completed.

DEHYDROFREEZING OF VEGETABLES - WU

Progress and Findings - Work has been continued by WU on dehydro-frozen vegetables, with particular emphasis on adapting laboratory procedures to commercial scale operations and on development of continuous drying equipment suitable for the dehydration step in the dehydrofreezing process. Such equipment is necessary in order to achieve more uniform drying and lower drying costs than are obtainable by the conventional tunnel-and-tray dehydrators now in use. A new type of through-flow rotary drier, originally developed by WU engineers for use in the fruit dehydro-canning process, was modified to meet the special needs of the dehydrofreezing process. The drier is a semi-commercial scale unit designed for operation in a continuous processing line. Considerable interest in this drier has been shown by members of the dehydration, freezing and canning industries, and test runs have been made in several plants under cooperative agreement. Results of these and other smaller scale dehydrofreezing tests involving a number of different vegetables have in general been very encouraging.

Late in 1953, the semi-commercial through-flow drier was installed in a commercial dehydration plant at Modesto, California, for trial use in the production of dehydrofrozen pimentos. This effort was only partially successful. The material produced by the drier was of excellent quality, far superior to tray-dried pimentos, but serious difficulty was experienced in continuous operation of the drier. After about two hours of operation, the pimentos began sticking to the drum of the drier, causing a drop in capacity and interference of flow of drying air. A new drier design has been developed in an attempt to overcome this difficulty, and construction of a model of the new design is in progress.

Dehydrofrozen pimentos have apparently become an accepted commercial item, having been produced for two successive seasons with a third in prospect. It has been reported that 500,000 pounds of dehydro-frozen pimentos will be packed this year as compared with 120,000 pounds last year. Most, if not all, of the dehydrofrozen product is being purchased by a large food company to meet approximately one-third of its total requirements for pimentos. This company is so well impressed with the quality of the rotary-dried material, that they plan to exclude the conventional tray-drying method for pimentos in the dehydrofreezing process. Use of wooden trays results in non-uniformity of drying and involves a serious inspection problem to remove splinters that are introduced into the product through scraping of the trays.

During the 1954 pea season, the rotary through-flow drier was installed in a cooperating commercial processing plant at Umatilla, Oregon, and used successfully in the production of approximately 11,000 pounds of dehydrofrozen peas from 22,000 pounds of fresh shelled peas. Some of this product has been purchased by the U. S. Army Quartermaster Corps for evaluation, and the remainder is being used by a large food processor for trial use in soups and other prepared canned and frozen food preparations.

The successful demonstration of the rotary drier for the partial drying step in the dehydrofreezing of peas is expected to encourage more rapid acceptance of the dehydrofreezing process, as a means of reducing the packaging, freezing and transportation costs of such products. The design of a practical commercial scale drier for use with peas now appears to be feasible. The management of the Umatilla plant is, in fact, considering installation of such a drier for the next pea processing season.

Laboratory samples of dehydrofrozen carrots, celery, peas and snap beans that were prepared last year for testing have since been evaluated by manufacturers of canned soups and similar items. These were found to be quite satisfactory with the exception of snap beans where some rehydration problems were encountered. Interest stimulated by these samples has resulted in other companies arranging to pack small lots of dehydrofrozen carrots, celery, lima beans, okra and sweet peppers during the current season for subsequent market testing.

All dehydrofrozen vegetables produced to date have been for use in remanufacture or for institutional use. There seems to be no current commercial interest in marketing in consumer-size packages.

Plans - Work will be continued on dehydrofreezing of vegetables in cooperation with food processing companies in order to adapt laboratory or pilot-plant procedures to plant-scale operations; to develop continuous drying equipment suitable for commercial application, with particular reference to commodities which have a tendency to stick to the drier surfaces; and, to determine the suitability of dehydrofrozen vegetables for remanufacture.

Publications

Dehydrofreezing of Fruits and Vegetables. William F. Talburt and F. E. Lindquist, Food Science Abstracts 26(4), 361-368 (1954)

Recent Progress in the Dehydrofreezing of Fruits and Vegetables. W. F. Talburt and F. E. Lindquist, Presented at the 14th Annual Meeting, Institute of Food Technologists, Los Angeles, June 1954.

TOMATO JUICE CONCENTRATES AND PASTES - WU

Progress and Findings - Continued effort has been devoted to the preparation of concentrated tomato juices and to a study of quality deterioration of such products and of tomato pastes by WU. This work is particularly timely in view of the interest of a number of tomato processors in the West in changing the standard of identity to permit the marketing of an unfrozen concentrated tomato juice labelled as "concentrated tomato juice." Present standards of identity do not permit such a label since by definition, as prescribed in the standards of identity for tomato paste, it must be labelled "tomato paste." However, tomato juice concentrate is in commercial production on an experimental basis and will probably be marketed under a temporary permit during the coming year.

Procedures are now available for preparing satisfactory concentrated tomato juice. Studies have shown that in contrast to citrus and many other juices, the typical flavor of tomato juice is developed during processing and subsequent storage. Also, unlike most fruit juices, the flavor of tomato juice was found to be practically non-volatile. As a result, little or no flavor is lost during evaporation and there is no need to add back an "essence" or "cut-back" juice to restore flavor to the concentrated product.

Studies have shown that little or no change in flavor or color of single-strength tomato juice occurs when it is kept at 77°F. for six months and a loss of only about 10 percent vitamin C was found. However, samples kept at 100°F. developed marked off-flavors and ascorbic acid losses were considerably greater. Deterioration in flavor and darkening of color of commercially prepared tomato pastes or concentrates became more marked as the concentration and temperature was increased. For example, a paste with 29 percent solids developed a scorched off-flavor, darkened considerably, and lost over 80 percent of its vitamin C content when stored for 8 months at 100°F., but there was relatively little change in flavor and color, and a loss of only about 22 percent of vitamin C, when kept for the same length of time at 77°F. At 32°F. this product remained essentially unchanged in all respects. The paste containing 38 percent solids was dark brown after only 3 months at 100°F., had developed objectionable flavors, and had lost about 85 percent of its initial vitamin C content. Comparison of vitamin C contents after six months at 90°F. for single strength juice, 30 percent paste, and 38 percent paste showed losses of 15 percent, 43 percent, and 83 percent, respectively. These results are of considerable interest to the tomato processing industry since they point out the stability problems inherent in the higher solids pastes now being produced. Only recently, 38 percent pastes became commercial items and last year one company packed paste with 46 percent solids.

Plans - Further studies are in progress on factors affecting the flavor and stability of tomato concentrates and pastes of various densities.

TOMATO JUICE POWDER - WU

Progress and Findings - This work was somewhat expanded by a readjustment of program within the Western Utilization Research Branch.

Work has been continued to develop practical methods for preparing tomato juice powder. Substantial progress has been made on vacuum drying procedures, particularly in reducing the time required for the drying cycle and in developing specifications for concentrated juices that will dry satisfactorily.

It has been found that concentrated tomato juice or paste containing more than about 40 percent solids does not dry satisfactorily with vacuum drying procedures developed to date. It was also found that powder prepared from certain lots of commercial pastes would not reconstitute properly even in boiling water, whereas other lots of powder reconstituted readily in ice water. Results obtained to date indicate that this difference is due to the amount of soluble pectin in the material being dried. Concentrates containing above 3 percent soluble pectin (dry basis) have generally yielded powders with satisfactory reconstitution characteristics. Those containing lower amounts of soluble pectin become increasingly difficult to reconstitute. Pectin content of tomato concentrates can be controlled over a fairly wide range by proper selection of processing procedures. The so-called "hot-break" method, which employs heating the tomato pulp to 180°F. or above immediately after crushing, favors pectin retention by destroying pectin degrading enzymes before they can act on the pectin. Lower heating temperatures permit greater destruction of pectin.

Studies were undertaken to determine the maximum product temperature that is permissible during vacuum drying if heat damage and off-flavors are to be avoided. No off-flavors were found in samples where product temperatures did not exceed 150°F., but at 160°F. and above, definite off-flavors were present. The addition of small amounts of sodium bisulfite (about 500 p.p.m., dry basis) to the concentrate prior to drying permitted a product temperature of 190°F. to be used with no evidence of heat damage. This quantity of sodium bisulfite in the initial tomato paste was not detectable by taste in the reconstituted powder. With a maximum product temperature of 150°F., drying times of about 2.5 hours were required to prepare

a powder containing 3 percent moisture. By raising the temperature to 190°F. during the latter stages of the drying cycle, time was reduced to about 1 hour. This substantial reduction in drying time may be an extremely important factor in determining production costs for vacuum drying.

Recent work indicates that tomato juice powder of good initial quality can also be made by a spray drying process. This method of drying is usually considered to be considerably cheaper than vacuum drying techniques. In the past, both laboratory and commercial-scale efforts to produce a spray dried tomato juice powder have been unsuccessful. Products dried to the low moisture level required to prevent caking could not be made without severe impairment of flavor. The greatly improved new product is the result of substantial changes in spray dryer design, establishment of specific operating procedures and conditions, and modification of the initial tomato paste to improve its drying properties. However, optimum production conditions and time-temperature stability of the product must be determined before the importance of this new development can be fully evaluated.

The spray dried product does not reconstitute as readily as the vacuum dried material. However, in instances where ease of reconstitution is not a factor, economic considerations should favor the spray dried product.

Investigations of the stability of vacuum dried tomato juice powder have shown that the powder is quite stable even when held at 100°F. for six months, providing the moisture content is sufficiently low and oxygen is excluded from the powder. Samples employing air as the package atmosphere have developed considerable off-flavor even when held at 70°F. and have become somewhat lighter in color. When properly packaged, tomato juice powder has been shown to be remarkably stable with regard to flavor, color, and vitamin retention.

Preliminary cost estimates indicate that tomato powder cannot compete with paste for use in remanufacture on the basis of cost alone. However, the powder offers distinct advantages as a base for tomato juice over canned single strength juice from the standpoint of economies in packaging, transportation and storage. It has advantages over pastes or other liquid concentrates from the standpoint of quality retention. In addition, it seems that the powder may find wide application in the preparation of an entirely new line of dehydrated products such as soups, catsup, sauces, and aspic. Increasing interest in such utilization is being evidenced by both civilian and military organizations.

Plans - Work will be continued on tomato juice powder at about the same level with somewhat more emphasis on spray drying. Stability studies on spray dried powder will be initiated. Studies to determine production costs of both vacuum and spray dried powders will be continued.

Publications

Problems in the Production of Tomato Juice Powder. V. F. Kaufman, F. Wong, D. H. Taylor and W. F. Talburt. Presented at the 14th Annual Meeting, Institute of Food Technologists, Los Angeles, June 1954.

Desiccating in the Package. W. F. Talburt, C. E. Hendel and R. R. Legault. Food Engin. 26 (4), 79-81 (1954).

Observations on the Rate of In-package Desiccation. C. E. Hendel and R. R. Legault. Food Technol. 8, 189-191 (1954).

In-package Desiccation of Dehydrated Foods. C. E. Hendel and H. K. Burr. AIC-373 (1954).

Retention of Quality in Dehydrated Vegetables through In-Package Desiccation. R. R. Legault, C. E. Hendel and W. F. Talburt, Food Technol. 8, 143-149 (1954).

FUNDAMENTAL CHEMISTRY OF BROWNING - WU

Progress and Findings - Investigation of the fundamental chemistry of non-enzymatic browning involving reactions between amino acids, the building stones for proteins, and sugars has been continued by WU.

In order to obtain the basic information needed, very simple chemical compounds are being used at the Western Regional Research Laboratory as models for the more complex sugars and amino acids found in vegetables. With these simple compounds, reaction products are correspondingly more simply and easily identified in the successive stages that lead to browning.

Several crystalline colorless reaction products have been isolated from reactions occurring in these simple model systems. One of these compounds, a condensation product of dihydroxyacetone and cyclohexylamine, decomposes on heating to yield compounds which brown readily in solution or when exposed to the atmosphere. Identification of these decomposition products has provided several important new clues for further investigation. It has also been found that under certain conditions a few parts per million of manganese will markedly inhibit the browning of glucose-amino acid solution and that small amounts of iron will accelerate the reaction. This effect of trace elements on the browning reaction has not been reported before, and may prove to be extremely valuable in elucidating the mechanism of the browning reaction and may provide a means of preventing or inhibiting this reaction.

Plans - Studies of the chemistry of browning through work on simple systems will be continued at the same level with particular emphasis on the role of trace elements in the reaction. Elucidation of the reactions involved should lead to development of methods for inhibiting deleterious browning phenomena in vegetable products.

Publications

Reaction Between Glycine and the Hexose Phosphates. S. Schwimmer and H. S. Olcott, J. Amer. Chem. Soc. 75, 4855-6 (1953).

Brown Condensation Products from Acetaldehyde and Aliphatic Amines. J. F. Carson and H. S. Olcott, J. Amer. Chem. Soc., 76, 2257 (1954).

STABILIZATION OF DEHYDRATED VEGETABLES - WU

Progress and Findings - Investigation of stability of dehydrated foods held for prolonged periods in military warehouses has been continued, in order to obtain information on the relative rates of quality deterioration at several locations. The work is being conducted in cooperation with the Office of the Quartermaster General, the Office of Naval Research, and the University of California. One of the two Armed Forces installations selected for this work is located at Stockton, California, where high temperatures prevail for several months of the year; the other is at Oakland, California, where temperatures are relatively low the year round. A third location is the White Mountain High Altitude Research Station operated by the University of California (elevation 12,500 feet). This location was selected as being particularly suitable for long-term stockpiling of emergency food supplies since temperatures there are low most of the year.

Samples of dehydrated vegetables, processed and packaged in accordance with military specifications, were obtained from military procurements and placed at each of the three locations for two years. Deterioration in acceptability of the samples, as measured by losses of vitamin C and non-enzymatic browning, has been determined.

After two years, ascorbic acid retention of 60 to 80 percent was found in samples kept at the Stockton installation (high temperature). Substantially higher ascorbic acid retention was found in products held at the other two locations, with 70 to 90 percent at Oakland and 90 percent at White Mountain. Although all samples were considered to be acceptable after two years, considerably more browning had occurred in those held at Stockton than in samples held in the two cooler areas. Quality advantages obtainable through warehousing semi-perishable items such as dehydrated vegetables in cooler areas are sufficient to justify this procedure where such products are warehoused for extended periods of time.

Plans - This project has been discontinued and no further work along this line is contemplated as the basic objectives have been accomplished.

COOLING OF BLANCHED SPINACH FOR FREEZING - WU

Progress and Findings - Blanched spinach cooled in the tubular cooling device built at the Puyallup, Washington laboratory was found to lose only about half as much soluble solids as when cooled in a water bath where the spinach was in direct contact with water. It was shown, however, that there is about 10 percent greater conversion of chlorophyll to phenophytin in the tube-cooled spinach than in water-cooled spinach. This is evidence that the rate of cooling in the tubular cooler is somewhat slower.

Although the tube-cooling method shows some advantages over water-cooling blanched spinach in a flume, with respect to the need for dewatering and reduction in loss of water-soluble constituents, no further work on this method of cooling is planned. Interest in the problem has greatly diminished since the volume of spinach processed in the area has declined rapidly in the past two years and many processors have discontinued packing spinach.

Plans - Work under this project has been completed and is being discontinued.

PROCESSING QUALITY OF RIO GRANDE VALLEY TOMATOES - SU

Progress and Findings - In cooperation with Substation No. 15 of the Texas Agricultural Experiment Station, work has continued at the Weslaco (Texas) laboratory on the determination of suitability for canning of selected varieties of tomatoes grown in the Lower Rio Grande Valley. Ten promising strains have been selected for further testing from a large number grown by the Experiment Station. These have been selected on the basis of yield, uniformity, color, firmness, and other growth characteristics; and trial packs of each selection were canned with and without the addition of calcium. After storing for six months, the canned tomatoes were examined and graded on the basis of wholeness, color, texture, total solids, acidity pH, taste, and flavor. The most promising selections are being grown again for a repetition of evaluation.

Strain W7, a tomato showing promise for the green wrap use, was fully ripened and used for more extensive canning trials. An objection to this tomato is lack of firmness. Use of calcium in the blanch water and with the salt in canning resulted in a 22% increase in "wholeness" of the canned product. In order to measure more accurately the firmness of tomatoes a pressure testing device has been constructed and used in evaluating the firmness of all tomato strains.

Plans - In addition to repeating the evaluation of canned tomatoes from selected strains it is planned to use a color difference meter to obtain accurate and comparable measurements on both the surface and inside color of the best varieties. Firming of the tomatoes by the use of calcium in the blanch water will be repeated under commercial conditions to determine if the procedure is of practical value to canners. At the request of Valley canners a study will be made of methods of removing fly eggs and insect contamination from the surface of tomatoes prior to canning.

- M. Proposals for Committee Consideration - Expand investigations on the development of new and improved vegetable juice and puree concentrates, vegetable powders and dehydrofrozen vegetable products. Developmental work should include investigation of improved equipment for concentrating vegetable purees such as, for example, a single-pass evaporator, incorporating steam injection preheating. Investigation of processing methods should include factors affecting reconstitution characteristics or convenience of use, flavor, color, consistency, nutritive qualities, stability, and general consumer acceptability. Work on vegetable juices should include blends as well as single products.

IMPROVED PROCESSING OF SOUTHERN PEAS - SU

Progress and Findings - 1954 Recommendation "Initiate research to develop procedures for canning Southern peas." (15/18)

Investigations have been continued at the Weslaco, (Texas) laboratory on improved processing technics for frozen and canned southern peas (blackeye, purple hull, cream). In cooperation with Substation No. 15 of the Texas Agricultural Experiment Station, ten of their most promising selections of peas have been canned and evaluated as to the quality of the resulting pack. Processors, especially freezers, are using more and more purple hull rather than blackeye peas for processing. Several of the selected strains show improved yield and processing quality. Work has continued on methods of grading Southern peas in respect to maturity. Using blackeye and purple hull peas, research with the tenderometer (an instrument used to determine maturity of English peas) has demonstrated that a linear relationship exists between maturity, can fill, and drained weight of the canned peas. Tabulation and charting of these data will provide a useful guide for canners using tenderometers to obtain a more uniform quality pack of peas. Comparison of tenderometer measurements on the two varieties shows that purple hull are of much more uniform maturity when picked than are blackeye peas. Differences in appearance, taste and texture result when peas of different levels of maturity are canned; but application of this information to improvement of the pea pack awaits a practical method of grading. Continued work has further demonstrated the effectiveness of froth flotation cleaning for removing pod pieces, skin, insect fragments and debris from shelled Southern peas.

Plans - In continued work, approximately 18 promising selections will be evaluated for canning quality. In another series of experiments blackeye peas will be sized, using a new rotary screen, then brine-floated to ascertain whether separation of different maturities is possible. Using the tenderometer on sized and brine-floated peas, additional data on can fill in relationship to maturity will be obtained.

PREPARATION OF OKRA FOR FREEZING - SU

Progress and Findings - 1954 Recommendation "Initiate work for acquiring basic information as a guide for developing optimum procedures in preparation of okra for freezing." (16/18)

No funds have been made available for initiation of systematic work in this field. Some assistance has been rendered packers in connection with processing problems. This past season one of the larger freezers in the Lower Rio Grande Valley experienced difficulty with discoloration of cut frozen okra. Studies of the product and laboratory tests by the Weslaco station demonstrated that the discoloration was due to underblanching of a portion of the pod. Changes in operation of the blancher to eliminate air pockets and increase the blanching temperature eliminated the processor's difficulty. Considerable quantities of okra are raised in South Texas for freezing and fresh market shipment.

- N. Proposal for Committee Consideration - Initiate work to acquire basic information to guide development of optimum procedures in preparation of okra for freezing. Production of frozen okra has expanded rapidly in the Southern states.

CANNED AND FROZEN SWEET CORN IN THE RIO GRANDE VALLEY - SU

Progress and Findings - 1954 Recommendation "Initiate research on the relation of stage of development and harvesting and handling techniques to the final quality of canned and frozen packs of sweet corn grown in the Rio Grande Valley." (18/18)

No funds were available for initiation of work in this field.

UTILIZATION OF BYPRODUCTS AND DISPOSAL OF WASTES

TOMATIDINE AND OTHER CHEMICALS IN VEGETABLES - EU

Tomatidine, a steroidal alkaloid, having antifungal activity toward plant and human pathogens, has been isolated from tomato leaves, stems and roots. Laboratory investigations at the Eastern Utilization Research Branch have shown that tomatidine can be a starting source of known steroid sex hormones. Only three chemical steps are required to convert tomatidine into the pregnene derivative which can be transformed into progesterone and testosterone. Following the isolation of tomatidine, its yield from a number of tomato varieties at varying stages of maturity has been determined. Conditions for harvesting, drying, and processing of tomato vines have been investigated and results are available which would make full-scale production possible. The importance of this work lies in the fact that tomato plants are widely grown in the United States. It is estimated that tomato plants grown specifically for the production of tomatidine would yield from 16 to 80 pounds of tomatidine per acre, depending on the tomato variety

and age at time of harvest. In some areas, and in particular irrigated land, tomato vines have a lush growth at the end of fruit harvest and may be used in the production of tomatidine. The development of an outlet for tomatidine would result in additional income to the American farmer either as a byproduct of present tomato plants or through plants grown specifically for tomatidine production. Structural work on tomatidine has continued during the past year and is essentially completed. In the process of elucidating its structure 20 new compounds have been prepared, some of which may have physiological activity different from that of tomatidine. Some of these new compounds are being tested now, while others are being prepared in larger amounts.

Other Solanaceous plants have been examined for alkaloids. Screening methods have been revised to give more positive results since in a few cases the widely accepted precipitating chemicals for alkaloids have given erroneous results. Each plant extract and isolated fraction is now being assayed for antifungal and antibacterial activity. Alkaloids have been isolated in small amounts from some plants but further work on these will necessitate the collection of additional plant material. Solanin was isolated from potato waste, then hydrolyzed to yield solanidine and solanthrene. These latter two compounds were separated by chromatographic means in a highly purified form. It was established that solanthrene is formed by dehydration of the steroidal alkaloid, solanidine, during acid hydrolysis.

Plans - This work will be continued on present scale of operation.

Publications

β -Sitosteryl D-Glucoside and β -Sitosterol from Commercially Dried Grapefruit Pulp, by R. M. Ma and P. S. Schaffer, Arch. of Biochem. and Biophysics, 47, 2 (1953).

Acid-catalyzed Reduction of Spirostanols and Spirostenols by Lithium Aluminum Hydride, by H. M. Doukas and T. D. Fontaine, J. Amer. Chem. Soc., 75, 5355 (1953).

Mull and Solvent Media for Infrared Use, by J. S. Ard, Anal. Chem., 25, 1743 (1953).

Grinders for Mulling Infrared Microsamples, by J. S. Ard, Anal. Chem. 25, 1780 (1953).

Report on utin Tablets, by A. Turner, Jr., J. Assoc. Off. Agric. Chem. 36, 699 (1953).

UTILIZATION OF CULL CARROTS - SU

Progress and Findings - There has been a tremendous increase in carrot production in South Texas in the last three years. Large quantities (an estimated 180 million pounds) of surplus or cull carrots were available from packing sheds and field operations during the last carrot season. The Weslaco (Texas) laboratory was asked to provide information to the Texas Growers and Shippers Association, and others interested in carrots, on possible means of utilization, carotene content, and results of dehydration for feed. Laboratory trials verified findings of the Eastern Utilization Research Branch and demonstrated the suitability of cull carrots for carrot chip manufacture. The possibility of utilizing them for extraction of carotene and production of feed is also being considered. The Bordo Products Company (Chicago) is erecting a plant for carotene and feed production; they expect to raise high-carotene carrots for carotene manufacture and utilize cull carrots in animal feed production. It is anticipated that the plant will have an initial capacity of between 30 and 60 tons of carrots per day.

Plans - No systematic work relating to this problem is possible within the limits of existing funds. Fundamental information is needed on the function and mechanism of formation of carotene in carotene-containing vegetables, including carrots.

NUTRITIVE VALUE OF WASTES

Progress and Findings - 1954 Recommendation "Initiate studies on the nutritive value of various wastes by feeding trials and by chemical studies." (17/18)

Resources have not permitted initiation of work directly in the area recommended. We are, of course, continuing research on the composition of vegetables, and part of the results obtained will contribute to the knowledge of nutritive value of vegetable wastes.

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B. Proposals for Committee Consideration

- A. Expand laboratory work and studies of "in practice" situation to determine losses and usable yields from vegetables of different market quality, fresh and frozen, and from common methods of handling in the kitchen. 61
- B. Expand the survey work on household uses of foods to obtain data in other communities and on other vegetables. 62
- C. Expand analyses of the food consumption survey data collected in 1955 to show (1) interrelationships among nutrients and dietary patterns, (2) the relative economy of vegetables in the light of present-day prices, consumption, and marketing practices, and (3) changes in the income-consumption relationships for foods since 1948. 63
- D. Expand research to obtain needed data on availability to the human body of important nutrients in foods, such as amino acids from various food sources. 65
- E. Expand basic investigations, including the microscopic and submicroscopic structure of plant tissue, to determine the constituents of vegetables of different varieties, at different stages of maturity, and as grown under different seasonal, locality, or other environmental conditions, and the role of these constituents on chemical changes which affect product quality. 73
- F. Expand investigations on the effect of agricultural chemical residues on flavor and other quality characteristics of processed foods. 74
- G. Expand studies to develop improved laboratory methods and procedures for determining the quality characteristics influencing palatability and generally associated with consumer acceptance of food. 77
- H. Expand studies leading to the development of new or improved methods and instruments for the objective measurement of quality factors in raw and processed vegetables. 81
- I. Expand nutritive value analyses to determine the content of important nutrients in foods as commonly processed and eaten. 83
- J. Expand investigations on the use of antibiotics (or other agents) in food preservation and on factors affecting heat resistance of spores of spoilage bacteria as a basis for improvements in vegetable canning methods. 87

B. Proposals for Committee Consideration (cont'd)

- K. Initiate research on the treatment of vegetable products with ionizing radiations either alone or in combination with heat, freezing, antibiotics and/or other treatments, for the purpose of improving quality and increasing stability, and study the effects of such radiations on the chemical composition, and texture of vegetable products. 88
- L. Expand studies on time-temperature tolerance and stability of frozen vegetable products in order to provide a sound basis for guiding process development so that products may be made more stable to the variable temperature conditions encountered in handling subsequent to processing, and to supply the necessary information for the establishment of a sound schedule for the distribution of frozen vegetable products in general. 90.
- M. Expand investigations on the development of new and improved vegetable juice and puree concentrates, vegetable powders and dehydrofrozen vegetable products. 102

III MARKETING RESEARCH

A. Progress on Work Under Way

MARKET ORGANIZATION AND COSTS

IMPROVEMENT IN RURAL MARKETING SERVICE - FCS

Progress and Findings - 1953 Recommendation "Initiate studies for the development and improvement of marketing agencies in areas near consuming centers." (22/25)

Funds were not provided for the initiation of this work.

- A. Proposal for Committee Consideration - Initiate studies for the development and improvement of marketing agencies in areas near consuming centers. These studies should analyze the experience and operation of rural marketing agencies that are rendering effective service to growers so as to determine which types of organizations or what modification of existing marketing agencies should be generally encouraged. For example, many growers are finding it necessary to develop plans to modernize marketing methods because farm packing has not brought about the quality pack and uniform grade that are sought by retailers and consumers. Producers also are finding it necessary to develop at the local market, sufficient volume and adequate facilities to meet the requirements of large-quantity buyers. Research into the best ways of developing these operations is desirable so that both producers and shippers have available to them information on methods of operation, costs, volume requirements, and other factors that will bring about sound business organizations.

This proposed work is a major item in scope and would include several coordinated studies in selected fruit and vegetable procuring areas. Several State and local groups have expressed interest in cooperating in studies of this problem.

COORDINATING THE MARKETING OF FRUITS AND VEGETABLES - FCS

Progress and Findings - 1954 Recommendation "Expand studies directed towards the development of coordinated marketing programs for deciduous fruits and vegetables." (23/25)

Work has just been initiated and information on buying and selling practices is being assembled from the retail and wholesale trade in several markets. The full time employment of one professional worker is required on this project. The study is designed to assist processors and shippers in developing more effective sales and merchandising methods and outlets by providing factual information on distribution methods, practices and costs. These data can be used as a basis for determining the type of marketing setup best suited to small and medium-sized processors and shippers.

Plans - Work will be continued on the analysis of distribution methods for both fresh and processed products which can be used in the formulation of integrated merchandising and sales programs, for both cooperative and independent processors and shippers. The first phase of this work will cover the more important processed products. It is estimated that this study should continue for a minimum of two more years.

MARKETING OF FARM PERISHABLES (Matching Funds -CES)

Progress and Findings - 1954 Recommendation, "Initiate on a matching fund basis, an analysis of problems in marketing locally produced fruits and vegetables in nearby consumer markets, by an east-central State experiment station." (24/25)

The Kentucky Station has just started work on the problem this fiscal year.

Plans - Data will be collected on the origin of the supply, quality and packaging requirements for food stores in buying milk, eggs, poultry, fresh greens, corn, tomatoes and beans. Data on the consumption patterns will be collected as well as establishing relationships between consumer preference and variety, quality and handling of perishables carried in retail food stores.

INCREASED EFFICIENCY OF CURING AND PACKAGING SWEET POTATOES (Matching Funds OES)

Progress and Findings - 1954 Recommendation, "Initiate on a matching fund basis, a study having for its purpose increasing the efficiency and decreasing the cost of curing and packaging sweetpotatoes, by an east-central State experiment station." (21/25)

This proposal submitted by the Tennessee Station was later withdrawn for consideration of Title II funds by their request.

MARKETING STUDIES IN CHRONIC PROBLEM AREAS - MOC, New England Research Council on Marketing and Food Supply

Progress and Findings - 1954 Recommendation, "Reactivate studies of marketing problems in areas where chronic marketing difficulties have occurred." (25/25)

The Boston Market Committee of the New England Research Council with the aid of some other interested parties has made a preliminary survey of the fruit and vegetable marketing situation in Boston, including some special attention to the problem of marketing locally grown produce. This preliminary work has been for the purpose of obtaining background information and developing hypotheses which would provide the basis for a thorough-going piece of research. It is expected that the latter would include an evaluation of the present economic position and future prospects of local growers.

Plans - A committee is now engaged in developing a detailed plan for a comprehensive research study. The Agricultural Marketing Service will continue its cooperative role in this work.

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FACTORS USED BY CONSUMERS IN IDENTIFYING QUALITY OF FRUITS AND VEGETABLES - MRD

Progress and Findings - 1954 Recommendation, "Initiate a study to determine the relative importance of factors used by consumers in identifying quality of fresh and processed fruits and vegetables." (Iowa)

This work was not initiated because neither personnel nor funds were available.

Plans - Negotiations aimed at activation of a study in 1955 will be opened with North Carolina Agricultural Experiment Station and possibly other agricultural experiment stations qualified to conduct this work on a cooperative basis.

INCREASED EFFICIENCY IN HANDLING AGRICULTURAL PRODUCTS (Matching Funds OES)

Progress and Findings - 1954 Recommendation, "Initiate on a matched fund basis work on increasing the efficiency of operation of firms handling agricultural products by a lake-State experiment station." (Low (d)) This study was initiated by the Michigan Station the beginning of this fiscal year.

Plans - Studies will be made to measure and compare costs and efficiency of alternate technologies, practices, procedures, and size of firms or plants handling agricultural products. The initial work will be with firms packaging and processing fruits and vegetables.

COMPETITIVE POSITION OF FROZEN FRUITS AND VEGETABLES IN THE WESTERN STATES - MRD, Western Region (WM-17)

Progress and Findings - 1954 Recommendation, "Initiate work on appraising the effects which the freezing of food has upon market outlets for farmers in different producing areas." (low (e))

The Agricultural Marketing Service as part of evaluating the effect which the increased use of frozen foods has upon market outlets and the location of producing areas will undertake work in cooperation with the University of California and Oregon State College in their studies of the competitive position of frozen fruits and vegetables in the Western States. This will be supplementary to the comprehensive study of the frozen food industry which is currently underway in AMS and may contribute to and in turn benefit from the western regional project.

Plans - After the preliminary period of investigation and planning is completed this year, it is probable that the Agricultural Marketing Service will assign at least one professional person to this project on a full-time basis.

MARKETING MARYLAND SNAP BEANS (Matching Funds - OES)

Progress and Findings - 1954 Recommendation, "Initiate on a matched fund basis, a study to compare the net returns from snap beans produced for the fresh market, and for processing by a mid-Atlantic State experiment station." (Low (f)).

Research on this problem has been initiated this fiscal year by the Maryland station.

Plans - The nature and operation of existing marketing organizations and facilities for snapbeans will be determined by personal interviews with individuals responsible for operations of facilities. Schedules are being designed to secure data on adequacy and effectiveness of facilities for handling volume of snap beans produced in Maryland, for canning and fresh market outlets.

MARKET PROSPECTS FOR FRUITS AND VEGETABLES IN THE SOUTHERN STATES - MRD

Progress and Findings - 1954 Recommendation, "Initiate a study to determine the consumption capacity and market potential in the southern states for fruits and vegetables." (Low (g)).

Neither funds nor personnel have been available to undertake this work during the current fiscal year.

Plans - A project involving preparation of a compendium on the marketing of fruits and vegetables in the United States is being proposed for committee consideration (see Proposals for Committee Consideration). If initiated this proposed project would result in the assembling of considerable information relating to the market potential and consumptive capacity for fruits and vegetables in the South. Beyond this proposal no work is presently contemplated in response to this particular 1954 recommendation of the Committee.

ADEQUACY AND EFFICIENCY OF SHIPPING POINT AUCTION MARKETS IN NORTH CAROLINA - MRD

Progress and Findings - As a phase of the Southern Regional Vegetable Marketing Project the North Carolina Agricultural Experiment Station and the Agricultural Marketing Service are cooperating in a study of shipping point auction markets in southeastern North Carolina. A survey of vegetable production and marketing patterns in the area has been completed and is being published by the North Carolina Station.

During the 1953 season data relating to the grade, variety and price received were collected on 4 of the 7 auction markets in the area. These data have been analyzed and a report is being prepared for publication. Meetings have been held in each of the markets studied so as to discuss preliminary findings which may assist both buyers and growers in planning for the coming shipping season.

The North Carolina Marketing Commission is making good use of this research in planning their program for improving the market facilities and market information in this area of the State.

Plans - Work will be continued in cooperation with the Regional Technical Committee. It has been suggested that a study be initiated which would consider the effect of factors such as size and color on the demand for cucumbers and green peppers. The Florida Agricultural Experiment Station, in addition, has asked AMS to cooperate in a study of improving the handling practices in moving sweet corn from shipping point to consumers.

Publications

Vegetable Production Patterns and Market Outlets, Southeastern North Carolina, 1952. A. D. Seale, Jr. and R. A. King. North Carolina Agricultural Experiment Station, A. E. Information Series 35. August 1954. In process.

Shipping Point Markets for Vegetables, Southeastern North Carolina. A. D. Seale, Jr. and R. A. King. North Carolina Agricultural Experiment Station, A. E. Information Series 34. January 1954. In process.

Vegetable Marketing Research in Southeastern North Carolina. A. D. Seale, Jr. and R. A. King. Progress Report. North Carolina State College. September 1954.

EFFICIENCY OF MARKETING WESTERN GROWN HEAD LETTUCE - MRD, Western Region (WM-14)

Progress and Findings - Work is continuing on this project in which the Agricultural Marketing Service and the California and Arizona Agricultural Experiment Stations are cooperating in carrying out one phase of the Western regional research in the marketing of head lettuce. A preliminary report of findings based on studies of field packing in the Salinas District of California was prepared and released by the California Agricultural Experiment Station in January 1954.

Since that time cost and physical input data relating to both field packing and shed packing of lettuce have been collected in the El Centro and Phoenix lettuce producing areas. Analysis of the various field packing methods is in progress. Production standards have been developed for each of the stages involved in the field packing operation. These standards show output per hour at each stage under "relatively efficient" operating conditions. Cost estimates based on these standards are also being developed. A comprehensive report on the field packing operation is expected to be available early in 1955.

When the study of shed packing of lettuce has been completed this operation will also be analyzed and then compared to field packing. Workers on this project are of the opinion that field packing is likely to gain further ground in this industry because of the lower costs involved in this method of packing.

Plans - Continue the project on substantially the same level but with emphasis shifted from harvesting, packing and shipping to the effects of type of container and method of cooling on comparative efficiency and costs.

Publication

The Effect of Work Method and Harvest Density on Costs of Field Packing Western Head Lettuce, Salinas District, California, 1953. Special Progress Report by F. J. Smith, L. L. Sammet and R. V. Enochian. Cal. Agr. Exp. Sta. January 1954.

IMPACT OF FROZEN FOODS ON MARKETING COSTS AND PRACTICES - MRD

A survey of the use of frozen foods by restaurants and cafeterias is now being conducted by a private research agency. Although the primary purpose is to obtain a picture of the use of frozen foods in public eating places, information is also being collected on the use of the corresponding fresh and canned items. Since there is a seasonal difference in the relative positions of all these foods in the restaurant industry, records of purchases are being obtained for two periods of 4 weeks each, one in the summer and one in the winter. In addition to the purchase data, the reasons for use and nonuse of specific frozen items have been obtained from approximately 500 restaurants and cafeterias representing a cross section of the industry. The results of this study are in the process of publication.

Surveys are being made of the quantities of the individual fruits used in the fresh, frozen, and canned forms by (1) pie bakers, (2) preserve manufacturers, and (3) ice cream manufacturers. The surveys of pie bakers and preserve manufacturers have been completed. Replies have been received from over 90 percent of the pie bakers and 80 percent of the preserve manufacturers who made up the survey sample. It is estimated that firms included in this sample represent some 80 percent of the total volume. The survey of the ice cream manufacturers is in progress with similar cooperation in prospect. Progress reports have been prepared for both the pie bakers and preserve manufacturers surveys. Final reports of these surveys are in the process of publication.

A pilot study has been undertaken to determine the feasibility of obtaining from distributors' records the monthly movement of selected frozen foods into retail outlets. The study includes two cities, Philadelphia and Washington, D. C., and will cover a six-month period. The results will be reviewed with distributors.

Publications

Purchases of Frozen and Canned Foods by Urban Families as Related to Home Refrigeration Facilities. H. W. Bitting. Marketing Research Report No. 60. February 1954.

Availability and Display of Frozen Foods in Retail Stores in Washington, D. C. Dehard B. Johnson. Marketing Research Report No. 73. August 1954.

Quantities of Fruits Used by Pie Bakers. Henry T. Badger, Progress report in process.

Quantities of Fruits Used by Preserve Manufacturers. Robert B. Reese. Progress report in process.

ASSEMBLY AND DISTRIBUTION OF FRUITS AND VEGETABLES IN THE HONOLULU MARKET - MRD, Hawaii Agricultural Experiment Station

Progress and Findings - This cooperative project which has been in progress since 1951 has thus far been directed into three distinct lines of work. In the first phase a survey was conducted among Honolulu consumers for the purpose of determining their consumption of and preference for cabbage, lettuce, tomatoes, cucumbers, carrots

and sweet potatoes in the fresh form. The published results indicate family consumption relationships based on income, size and racial origin. Consumer preferences and substitutions among the six vegetables are also reported.

Another study had as its subject the same six vegetables but in this case the emphasis was on margins, shrinkage and pricing of these commodities, at the wholesale and retail levels. A report covering the findings during an observation period extending from 1951 to 1953 has been published. Findings in this survey support the premise that retailers look upon their produce department as a unit and that they do not adhere to any rigid or consistent pricing policy so far as individual commodities are concerned. It was also found that super-markets have a definite buying advantage over smaller stores but that they are passing only part of that advantage on to consumers in the form of lower retail prices.

The third part of this project has been concerned with costs of hauling fresh fruits and vegetables in Hawaii. A report on average hauling costs representing Island conditions has been published. Another report on costs of delivering fresh fruits and vegetables in the Honolulu market is being prepared and is expected to be published shortly. These reports provide a basis for computing hauling costs and an evaluation of the delivery service provided by Honolulu produce dealers.

Plans - The report on delivery costs will be completed and published. Further work under this project is dependent upon availability of personnel. The Hawaii station has been experiencing unusual difficulty in recruitment of qualified personnel to conduct marketing research. It is probable that the next field of research may have to do with costs and efficiency in assembling, packing and shipping fruits and vegetables that are produced in the Islands and marketed in Honolulu.

Publications

Truck Hauling and Delivery Costs Representing Island Conditions. Robert H. Reed. Hawaii Agricultural Experiment Station. Agr. Econ. Rpt. 17. May 1953.

Family Consumption of Certain Fresh Vegetables in Honolulu. Robert H. Reed and C. Richard Creek. Hawaii Agricultural Experiment Station, Agr. Econ. Bul. 5. June 1953.

Margins, Shrinkage and Pricing of Certain Fresh Vegetables in Honolulu. C. W. Peters, Robert H. Reed and C. Richard Creek. Hawaii Agricultural Experiment Station, Agr. Econ. Bul 7. June 1954.

METHODS AND COSTS OF PROCESSING SWEET CORN - FCS

Progress and Findings - Information obtained on the cost of processing sweet corn is being analyzed and prepared for publication. In addition to the use of these data previously reported, other important findings are being developed and among these are: there is an important indication that case yields per ton of raw product are closely correlated with variations in direct labor costs. This close correlation suggests direct labor costs allocation factors may be derived on the basis of case yields. This would make possible a more efficient method of determining direct labor cost allocation factors than the present one of using time studies. This close correlation between case yields and direct labor cost variations strongly suggests greater emphasis should be placed on paying for raw products on a grade basis rather than the present field-run basis generally used by canners.

Plans - With the publication of data already obtained, this study will be completed.

Proposals for Committee Consideration

- B. Reactivate the study of costs of processing deciduous fruits and vegetables. A limited investigation of costs of canning and freezing certain fruits and vegetables was made by the Bureau of Agricultural Economics in 1949 and 1950. Another activity suggested for further checking as to practicability is the establishment of an index of major processing costs that would be computed on an annual basis.
- C. Initiate a study designed to measure the effect on shipping point prices of operating practices engaged in by the various buyers in local markets. This study would be concentrated in a limited number of local market areas where a sizable volume of vegetables is produced and offered for sale. It is believed that this study may provide at least partial explanation of some of the price fluctuations that occur so frequently in the marketing of fresh produce.
- D. Initiate a study of trading in onion futures. Price fluctuations that are sometimes violent and the possibilities of extreme profits and losses in trading have brought about some question as to the desirability of operating a futures market for a perishable commodity such as onions. There has developed considerable interest in the extent of speculation or other possible abuses of this futures market. The effects of such trading on returns to growers and on marketing practices have also been the subject of questioning. A study of the

futures market for onions would provide a description of these activities that should result in a better understanding of the process by growers, shippers and others interested in the welfare of the industry. In this study some attention would be devoted to considering the practicability of hedging on the part of growers, shippers, wholesalers and even processors. Basically, however, the objective of the research would be to assemble information needed for objective evaluation of the effects, both good and bad, of futures trading on the interests of growers and shippers. This study could logically be conducted as a companion to a similar project involving potatoes.

- E. Expand work on a compilation of information that will show trends in the marketing of vegetables. It would also be expected to show significant changes that have occurred in the marketing system and in the production pattern with particular reference to changes in handling methods resulting from technological factors that affect both production and marketing. Differences in size and function of firms engaged in the marketing of fresh and processed vegetables would be considered as another facet of the study.
- F. Initiate studies on methods of purchase of raw product by fruit and vegetable canners, types of grower-canner contracts and current bargaining methods. The study will assist in the further development of economically sound market outlets for producers. Many canning crops are still purchased on a flat price basis, rather than by available grading methods. Study is needed on the relative advantages of using scientifically determined grades compared with purchase methods on a nongrade basis. Comparison of prices, grades, and services to growers will be made for specific canning crops in different production areas.

A survey of current fruit and vegetable bargaining associations and their methods of operation also will be included. In other commodity fields bargaining associations have improved marketing of farm products and under sound methods of operation similar benefits may be obtained by growers of canning crops.

- G. Initiate studies with cooperatives and other processors for selected fruits and vegetables to determine the optimum use of processing plant, feasibility of introducing new product lines, market potential for various forms of processed products, and off-season use of plant and personnel. This study would analyze the actual vs. optimum use of plant facilities, the extent to which the use of the plant could be increased or combined with other operations, and the possibilities of

processing commodities not being handled in current production. Representative plants would be studied to determine the feasibility of adding units of production in existing plants, changing commodity forms, or producing new commodity lines. Buyer preferences and the possibility of expanding outlets through development of secondary or non-competitive markets for processed commodities would be examined along with an analysis of market potential and relative advantages of diversification of commodity lines, new product forms, can sizes, packages, and frozen vs. canned products. Development of off-season uses for processing plant facilities and personnel, such as warehousing and other business uses also would be studied.

MAINTENANCE AND EVALUATION OF PRODUCT QUALITY

PREPACKAGING AND FILM LINERS FOR CONTAINERS - MRD

Progress and Findings - 1954 Recommendation, "Expand work on pre-packaging of fresh vegetables." (1/25) Slight expansion made with present funds.

Sweetpotato Prepackaging - The chief problem in earlier studies on prepackaging sweetpotatoes was preventing development of decay. These studies were continued at Beltsville to work out better control of decay. Orange Little Stem sweetpotatoes were used after curing 10 days at 85°F. immediately after harvest. They were stored 1 to 3 months at 55° before washing and inoculation with *Rhizopus* spores in the wash water. After washing and packaging some lots received a second curing treatment of 3 days at 85° to heal washing and packaging injuries. All lots were subsequently held 1 week at 70° or 2 weeks at 55° plus 1 week at 70° to simulate possible marketing conditions. Spread of *Rhizopus* decay within the packages soon made many packages unmarketable and prevented a satisfactory shelf-life. The second cure or recuring treatment after packaging was more effective in reducing decay on sweetpotatoes held 1 month at 55° than it was on those held 3 months at 55°. Recuring was more effective when it was done immediately after washing and packaging than when the washed sweetpotatoes were allowed to remain at 70° for a day before packaging.

Plans - These studies are to be continued.

Publications

How to ventilate packaged produce, by R. E. Hardenburg. Pre-Pack-Age 7(6): 14-17, February 1954.

Government tests show value of produce prepackaging, by R. E. Hardenburg. American Paper Merchant 51(4): 20-22, 65. April 1954.

Prepackaging horticultural products - a bibliography, by R. E. Hardenburg. QMI Section Mimeo. 10 pp. December 1953.

Prepackaging Cole Slaw - Cole slaw, like the prepeeled potatoes, maintains a more desirable white color in sealed than in perforated cellophane bags. When the sealed bags were opened, however, and the slaw examined for odor and flavor a slightly fermented or sour condition was noticed after only 1 day at 70°F. Thus a slight amount of package ventilation would appear to be desirable even though darkening is hastened. Gas analyses of the atmosphere in many sealed packages showed an average accumulation of 25 percent carbon dioxide and a depletion of oxygen to 5 percent in 1 day at 70°. The carbon dioxide and oxygen in many sealed packages containing cole slaw which previously had been dipped in 0.1 percent streptomycin sulfate a good bactericide, average 23 and 5 percent respectively. This indicates that the accumulation of carbon dioxide is probably due to respiration rather than to bacterial action. Cole slaw treated with streptomycin sulfate and packaged in sealed non-ventilated bags developed little of the sour odor of fermentation characteristic of other sealed bags. Refrigeration at 32° was excellent for preserving freshness of packaged cole slaw.

Work reported last year from the New York Laboratory on the use of 1% lime solution to prevent darkening of cole slaw was continued on a "pilot plant" scale in cooperation with one of the large food chains. The results verified the laboratory tests and treatment was successful in extending shelf life of cole slaw by a day or two.

Plans - The problems of fermentation in cole slaw will be studied further.

Publications

Lengthening the shelf life of packaged cole slaw by J. Kaufman and J. M. Lutz. Pre-Pack-Age 8(1): 13-16. September 1954.

Prepackaged Diced Vegetables - A number of chemicals were tried during 1954 to determine their possible values in retarding discoloration and lengthening the shelf life of diced carrots and parsnips when packaged in plastic bags. The marketing of diced vegetables is a growing industry in the New York Metropolitan area. None of the treatments were effective when applied to carrots, but a one minute dip (without rinsing) in a 0.5 percent solution of sodium bisulfite consistently retarded the discoloration and thus lengthened the shelf life of diced parsnips.

Plans - These studies will be continued.

Prepackaged Radishes - Prepackaged topped radishes in small consumer bags is one of the newcomers to the line of prepackaged vegetables, and has assumed commercial importance in Florida, Ohio and Texas. The big advantage is the elimination of the tops which are extremely susceptible to mechanical damage and spoilage. A new problem has appeared in the form of small black spots on the radishes in film bags. A particular type of decay organism, *Pseudomonas* sp. was isolated from the spots by the New York Laboratory. In studies made at Beltsville, Md. isolations from black spots yielded 2 types of pathogenic bacteria, one white in culture caused soft rot of radish and cabbage and the other, yellowish in culture caused a black spotting similar to that on commercial radishes. The latter isolate causes black lesions and vascular discoloration of cabbage leaves.

Plans: Black spotting of prepackaged radishes will be studied further to determine its cause and remedy.

- H. Proposal for Committee Consideration - Expand research on fungicides for controlling post-harvest diseases of vegetables. Tests would be made to determine effectiveness of chlorine and other chemicals now used in wash water and hydrocooling water under experimental and commercial conditions. Also new fungicides and combinations of fungicides would be tested to develop more effective treatments than now in use and to develop control of diseases for which no satisfactory treatment has been developed. The fungicides will be tested for use as washes, dips, sprays, and fumigants. Special attention will be given to fungicides, including antibiotics, that can be used in wash water and hydrocooling water.

Publication -

Shelf-life of prepackaged radishes in relation to type of film, temperature and amount of trimming by J. M. Lutz, J. Kaufman and H. W. Hruschka submitted to Pre-Pack-Age.

Prepackaged Onions - Experimental work on prepackaging onions in 3 to 5 pound bags of paper, mesh, or transparent films was concluded in 1953 and some of the findings were in last year's report. A summary of studies at Beltsville, Md., stressing the importance of having 16 to 32 1/4-inch holes in film bags to provide needed ventilation was prepared in 1954.

Plans - Prepackaging studies on onions have been concluded.

Publication

Ventilation holes necessary for film-packaged onions, by R. E. Hardenburg. Accepted for publication in Modern Packaging, September 1954 (probable publication date, December or January).

Prepackaged Carrots - Ten test cars of California carrots prepackaged in perforated polyethylene bags were received. Most lots arrived with relatively little decay regardless of transit temperature but those which are subject to decay developed high percentages of decay in transit. One car in cartons arrived with 30 percent decay. Some of these prepackaged carrots developed a black mold (*Thielaviopsis basicola*) when held for 8 days at 69°F. This fungus has not been reported previously to occur on carrots. It probably developed because of the conditions of high humidity within the bags and the high storage temperature.

Plans - Further studies are planned.

Publication

Thielaviopsis basicola on carrot roots from California by B. A. Friedman. Submitted for publication in Plant Disease Reporter.

Damage to Fruits and Vegetables by Cellulose Acetate Films - In studies made at the New York City Laboratory three out of 8 different cellulose acetate films were found to cause injury to radishes and beans. None of these films injured lemons, mushrooms or spinach.

Ventilation of Prepackaged Produce - Generally fruits and vegetables packaged in tight films without ventilation maintain a good appearance longer than produce in ventilated packages. This is an effect of the modified atmosphere in a tight package. If this atmosphere could be regulated the effects might be beneficial to some products. Usually, however, this is not possible. The oxygen supply is exhausted, carbon dioxide accumulates, fermentation begins and the produce develops off-odors and off-flavors. Some form of package ventilation for film-packaged fresh produce has usually been recommended. During the year a summary of the ventilation conclusions from many research papers on prepackaging fruits and vegetables was prepared.

Plans - Studies will be continued on this important aspect of pre-packaging.

Publications

How to ventilate packaged produce, by R. E. Hardenburg. Pre-Pack-Age 7(6): 14-17, February 1954.

Government tests show value of produce prepackaging, by R. E. Hardenburg. American Paper Merchant 51(4): 20-22, 65. April 1954.

Prepackaging horticultural products - bibliography, by R. E. Hardenburg. QMI Section Mimeo. 10 pp., December 1953.

Film Box Liners for Ripening Tomatoes - With the renewed interest in ethylene for ripening tomatoes it was thought that a possible question might be -- if tomatoes give off ethylene as they ripen could film liners be used during shipment or in ripening rooms to trap the ethylene and thus stimulate ripening. Three types of film liners and regular paper liners were tested in standard lug boxes at Beltsville, Md., to determine their effect on rate of ripening of mature-green tomatoes and pink tomatoes held at 60°F. The value of the film liners for this purpose was negative. When mature-green tomatoes were packed in sealed polyethylene-lined boxes 94 percent were still entirely green after 13 days. The build-up of carbon dioxide to 10 percent and the depletion of oxygen to less than 1 percent within the film liner in the first 6 days almost completely inhibited any ripening. In check boxes without the liner only 3 percent were still green and the other 97 percent had ripened to a pink or red color satisfactory for pre-packaging. Similar results were obtained when pink tomatoes were held in sealed film-lined boxes. Non-sealed film liners allowed ripening to proceed, but there was no stimulation in rate over boxes with the conventional paper liners.

Plans - This work will be continued another year before the findings are published.

Polyethylene Crate Liners for Tomato Plants - Polyethylene bags and crate liners holding various numbers (25 to 600) of bare-rooted tomato transplants were compared with the conventional method of shipping, in which the roots of the transplants are packed in moist peat before wrapping with kraft paper or newsprint. In a cooperative shipping test with the Hort. Crops Branch, ARS, plants from Tifton, Ga., were sent to Beltsville, Md. The bare-rooted plants in small polyethylene 150 bags or in large polyethylene crate or hamper liners arrived in good condition with less wilting than plants shipped by the conventional method. The film-packaged plants withstood a 4-day holding test after arrival at either 70° or 50°F. before field planting, and

survival in the field was good. This method shows promise as a possible method of field packing tomato plants, without the use of imported peat. Some evidence was obtained showing that the film bags or liners should be perforated to prevent physiological breakdown.

Plans - More extensive tests are planned for the spring of 1955 before a report is issued.

PRECOOLING AND REFRIGERATION IN TRANSIT - MRD

Progress and Findings - 1954 Recommendations "Expand studies on refrigeration of fresh vegetables in transit." (2/25) No expansion was made.

Refrigeration of Prepackaged Carrots in Transit.

California - Within the last two years the packaging of topped carrots in 1-lb. film bags for shipment to eastern markets has increased very markedly. This method of marketing carrots has created problems of transit refrigeration not encountered in shipments of bunched carrots in which crushed ice is placed in the shipping crates. Still further problems in transit refrigeration occur when pre-packaged carrots are shipped in fiberboard containers which cannot be top-iced.

Results of the 1954 summer tests conducted at Salinas, California indicate that hydrocooling carrots before packaging is a practical way to remove field heat and obtain desirable temperatures during transit. When hydrocooling is not available, field heat can be removed economically by top icing the trailer loads of roots as they arrive at the packing house from the field; thus accomplishing considerable cooling before the carrots are dumped into the washers. The value of removing field heat promptly and of maintaining fairly low temperatures in transit was shown by good decay control and increased shelf life of the roots when the average transit temperature was 50°F. or lower. No publication has been prepared on this work but the results were presented informally at a meeting of growers and shippers in Salinas, Calif. in October. A report will be prepared.

Plans - This work will be continued. See proposals for expansion of refrigeration in transit studies.

Texas - In tests made in the Rio Grande Valley of Texas prepackaged carrots were more difficult than lettuce to cool after packing and loading. Although the carrot cartons were better vented than those used for lettuce, the additional packaging in polyethylene film bags, regardless of perforations, greatly reduced the rate of cooling. Cooling was further retarded by the solid crosswise loading pattern used early in the shipping season though possibly less by the later approved "chimney load". The commodity temperature of non-precooled carrots in the hard-to-cool middle layers at the quarter length position of the car could be expected to show a rise of several degrees during the first 36 to 48 hours in transit. Approximately 96 hours under fan service were required to reduce the commodity temperature from 72°F. to 60° in this part of the load. Heat removal from the center of the load was slow even under the best of conditions. In one car loaded lengthwise with channels between rows the commodity temperature was reduced only from 63° to 55° after 14 hours precooling with car fans when 2% salt was added to the bunker ice. Heat removal from prepackaged carrots harvested during periods of warm weather was obtained by a series of complementary operations. The prerequisites to prevention of spoilage in transit were (1) precooling before packaging; (2) prompt packaging after precooling; (3) loading cartons lengthwise with channels between rows; (4) car precooling after loading; (5) fan service with an icing service during transit.

Plans - This work will be continued with prepackaged carrots and possibly other commodities in cartons. See proposals for expansion of precooling and transportation studies.

Publication

The Fan Car - Fables and Facts. H. B. Johnson. The Texas Citrus and Vegetable Growers and Shippers - 1954 Yearbook.

Precooling and Transit Refrigeration of Dry Pack Lettuce.

Texas - The demand for Texas lettuce "dry-packed" in cartons created considerable interest in precooling in fan equipped refrigerator cars. There were no vacuum cooling plants in Texas for precooling the lettuce crop as there are in California and Arizona. No great difficulty was experienced in precooling carton-packed lettuce in fan cars. Although cartons were not well vented, the car loading pattern, with channels between rows, was ideal for air circulation through the load. Under normal loading conditions with 80°F. lettuce the average temperature of the load could be reduced approximately 20 degrees by operating

the car fans 6 hours when 2% salt was added to the initial bunker ice. Fan service with standard refrigeration provided additional cooling during transit. Commodity temperatures were generally below 40° after 3 days in transit. Poor condition on arrival in most cases could be attributed to little or no car precooling at the loading point.

Plans - This work will be continued during the coming season. Standard refrigeration with full bunker icing may be more refrigeration than is required in well cooled cars during winter months and car icing practices will be studied. See proposals for expansion of precooling and transportation studies.

California - Rate of cooling, transit refrigeration, and commodity condition studies were made on 9 carloads of dry-pack lettuce originating in the Imperial Valley during January and February of 1954. Vacuum cooling of carton-pack was compared with precooling in the car by means of bunker ice and fans. Body ice was tried as a means of cooling dry-pack lettuce in wire-bound half-crates and wire-bound packages were also vacuum-cooled and car-precooled.

The results indicated the following: (1) Vacuum-cooled lettuce in wire-bound crates could be satisfactorily refrigerated in transit with initial top ice only during the winter months. (2) Lettuce temperatures in transit averaged somewhat lower when top ice was used than when transit refrigeration was by bunker ice only. (3) Car-precooling with bunker ice and the built-in fans appeared to be satisfactory provided lettuce temperatures averaged less than 60°F. at loading and 10 to 12 hours was available for cooling in the car. (4) Carton-packed lettuce precooled more readily in the car when the load was row-spaced than when loaded solid. (5) Wire-bound half-crates precooled faster in the car than cartons of similar size.

Plans - These studies will be continued. See proposals for expanding studies on precooling and refrigeration in transit.

Publications

Precooling and transit refrigeration studies with winter lettuce from the Imperial Valley. Submitted to Western Grower and Shipper on October 7 for publication in December issue. A. L. Ryall, J. Kaufman, and W. R. Barger.

Transit refrigeration of carton-packed, vacuum-cooled lettuce during late summer and fall months. Published in September 1954 issue of Western Grower and Shipper. A. L. Ryall and W. A. Radspinner.

Precooling and transit temperatures of western lettuce. Published in Proceedings of Conference on the Transportation of Perishables, April 1954. A. L. Ryall.

Truck Transportation of Cauliflower - Twelve experimental truck shipments of cauliflower were made during the fall of 1953 from Long Island to southern markets. Providing additional channels along the floor layer by loading 5 instead of 6 rows wide was very beneficial in providing a better distribution of air and consequently cooler temperatures in the bottom layer. Bunker icing in addition to top icing was also helpful in cooling the load. Practically all carlot shipments of cauliflower from Long Island are being made by methods developed by this section.

Plans - These studies have been completed.

Publication

Truck shipping tests with Long Island cauliflower, 1953 by J. Kaufman and H. W. Hruschka. In press for AMS-H Report.

Keeping Car Fans Running at Terminals - Cars of perishables standing on track at terminal markets over the week-end may become too warm in top layers during warm weather. This may be a serious problem on such perishable items as dry-pack, vacuum cooled lettuce, not top-iced. By the use of a portable gasoline engine operating car fans it was possible to adequately refrigerate the top layers of pears and carton packed lettuce while cars are held at terminal markets. Reasonably good results were obtained by operating the floor fans in only one end of the car with these commodities. The gasoline engines can be used in the railroad yards where electricity is not available.

Plans - Further studies are planned.

Refrigeration of Tomatoes.

California - Losses sustained at the market by commercial ripeners and repackers of California mature-green tomatoes have been reduced from the 20 to 30 percent wastage of a few years ago to 5 to 10 percent by commercial acceptance of transit refrigeration methods based on research conducted by the Fresno field station in cooperation with coworkers in New York and Chicago.

The heavy losses of tomatoes from decay and poor ripening was found to be due largely to chilling injury caused by excessive cooling in transit. Chilling in transit was reduced by supplying the cars with amounts of ice based on fruit and outside temperatures at loading and by forwarding them with all ventilators closed - a practice not

formerly used by tomato shippers. During the 1953 shipping season an icing schedule adapted to commercial use was tried and proved to be successful in test shipments and in more than 300 commercial shipments from which reports were obtained. The system also proved successful for Mexican tomatoes forwarded from Nogales, Arizona. Cooperative tests with the University of California are in progress to determine the effect of different amounts of field chilling upon the ripening behavior of fall tomatoes.

Plans - Further shipping tests are planned to determine the effectiveness of the new icing schedule for tomato cars moving during more adverse weather than has been experienced to date and to determine the effectiveness of the system when applied to various types of equipment such as fan vs. non-fan cars and half-stage vs. full-stage equipment. See proposals for expansion of transit refrigeration studies.

Publications

Maintenance of intermediate temperatures in tomato cars. W. R. Barger, Proceedings of the Conference on Transportation of Perishables, Davis, California, April 1954.

Transit and ripening studies with California mature-green tomatoes. W. R. Barger, W. A. Radspinner, L. L. Morris. H.T.&S. Report No. 317 and Calif. Vegetable Crop Series No. 66. July 1954.

Protecting tomatoes from transit chilling. W. R. Barger. Yearbook of Western Grower and Shipper, Los Angeles, California, November 1954. Also submitted to Pre-Pack-Age, New York, New York.

Texas - Transit temperatures of 50° to 65° F. are desirable for mature-green tomatoes. This temperature range eliminates the possibility of chilling injury and permits some ripening to take place in transit and shortens the time the fruit must be held in ripening rooms by the receiver. Earlier test shipments from the lower Rio Grande Valley of Texas to Chicago indicated that initial and one reicing with vents closed to destination provided adequate refrigeration for tomatoes loaded warm. Eight additional shipping tests were conducted in May and June to develop more fully the limitations of initial icing and either one or two reicings with vents closed. Both reicing services are now available under Rule 247.

When tomato temperatures averaged 78° F. at loading, initial icing with one reicing provided temperatures near the minimum of the desired range after 5 days in transit. This protective service appeared to be

equally satisfactory when tomato temperatures at loading averaged 86°. The one reicing was scheduled at the second regular icing point or approximately 48 hours after initial icing. A 5-day transit period would be sufficient to reach either Jersey City or Pueblo, Colorado. The amount of ice remaining in bunkers after the transit period afforded protection for one to several days holding before unloading. The differences in tomato temperatures at loading could be observed in the ripeness of the tomatoes on arrival. The car of 78° tomatoes at loading arrived with 6% ripe, 7% turning, and 87% green. The load of 86° tomatoes showed 23% ripe, 32% turning, and 44% green, respectively.

With tomatoes warmer than 86° at loading two reicings appeared to be sufficient. In one test car of 92° tomatoes, with reicings made at the first and second regular icing points, the arrival inspection showed 44% ripe, 38% turning, 15% green, and 3% decay. Temperatures taken during the unloading operation (8 days after loading) ranged from 50° to 68°. Reicing at the first and third rather than at the second regular icing point would have provided lower temperatures at unloading. However the ice supply was never dangerously low during the 5-day transit period.

Operating the car fans resulted in cooling the loads more rapidly and more evenly than was possible in non-fan cars.

Plans - The work will be continued with emphasis placed on shipments to the Pacific Northwest and Canada.

Proposals for Committee Consideration -

- I. Expand investigations on methods of precooling vegetables. The removal of field heat from vegetables soon after harvest is essential to the preservation of quality and prolonging storage and market life. Additional benefits may be obtained by supplementary fungicidal treatments added during the precooling process. These packages introduce new problems of cooling because they are tighter than those formerly used and are loaded more tightly in the refrigerator cars or trucks. Information is needed on methods of speeding up cooling, how much can be gained by increasing air velocities or the volume of water used, or opening up the packages. Vacuum cooling, which has been so effective for lettuce, should be studied for its application to other vegetables.

- J. Expand research on refrigeration of vegetables in transit. Large savings could be made in rail refrigeration costs if icing practices were followed that were not wasteful of refrigeration. Half stage icing can be substituted for full bunker icing more generally than is the practice at present. Top-icing is overdone on melons and other commodities and often bunker icing is used when it is not necessary. For some commodities like tomatoes, overrefrigeration not only wastes money, but it damages the product and causes spoilage. Rail refrigeration services for vegetables should be brought closer to the needs of the commodity by expanded research and education. Refrigeration by truck and trailers is limited by the refrigerating capacity of the mechanical unit or ice bunker. Air circulation is often impaired by poor loading practices and inadequate floor-racks. Improvements could be made in truck refrigeration if more records were available on the performances of equipment now in use.

CHILLING INJURY OF VEGETABLES - MRD

Peppers - Preliminary tests at Beltsville, Md., show that chilling injury in bell peppers is indicated by decline of the calyx, by a physiological surface-scald, and by the occurrence of alternaria rot at the calyx and as spots over the surface of the fruits. Tests are in progress to determine the temperature and holding period necessary for the development of these symptoms. The study will also show the most satisfactory temperature for holding peppers and the maximum time they can be held safely from harvest.

Squash - Observations on a commercial shipment of acorn squash in which 85 percent of fruits had numerous spots of alternaria rot indicated that serious chilling injury had occurred. Preliminary controlled tests indicated that more than 12 days at 32° or 40° F. are required to cause serious chilling injury.

Tomatoes - Current season's work with tomatoes confirm earlier results. Alternaria rot was the most reliable indication of chilling injury. It did not develop appreciably in tomatoes held at 50° F. and 55° but exposure to 40° and 32° greatly increased susceptibility to alternaria rot. All of these temperatures retarded subsequent ripening at 65°. For example, 12 days at 55°, 50°, 40° and 32° retarded ripening at 65° by 3 1/2, 8, 16 1/2 and 18 1/2 days, respectively. Even 1 or 2 days at 55°, 50°, 40° or 32° retarded subsequent ripening.

It was not surprising to find that chilling may take place in the field. Three seasons tests at Beltsville indicate that mature-green tomatoes can withstand 250 hours below 50° F. in the field and ripen normally providing day temperatures are high and the low field-temperatures are accumulated over a long period (2 weeks or longer) and that the fruits are not subjected to further low temperature after harvest. Mature-green fruits harvested after 46, 82, and 196 hours below 50° developed only 2.8, 1.8, and 5.4 percent alternaria rot respectively during ripening at 65°. Similar fruits held at 32° for 8 days after harvest and then ripened at 65° developed 13.9, 45.3, and 76.3 percent alternaria rot. Fruits harvested after 232, 336 and 448 hours below 50° and ripened at 65° with no further low temperature developed 0, 31.7, and 76.2 percent alternaria rot.

Plans - Studies on peppers and squash will be continued. The work on temperature tolerance on tomatoes is almost completed. Additional studies of field chilling are contemplated. See proposals for expansion of research on physiological disorders such as chilling injury.

Publications

Ways to prevent chilling mature-green tomatoes. Pre-Pack-Age 7: 22-25, Feb. 1954. L. P. McCulloch and John T. Worthington.

QUALITY MEASUREMENTS AND NUTRITIVE VALUE STUDIES - MRD

Progress and Findings - 1954 Recommendation, "Expand work on objective evaluation of quality factors in fresh vegetables." (4/25) No expansion made.

"Expand research on preservation of nutritive value of vegetables." (19/25) Slight expansion made with funds allocated for this purpose.

Color of Tomatoes for Canning - During the 1954 season the work was continued to develop a method for grading cannery tomatoes based on an objective evaluation of color, using raw juice media, and a subjective determination of the percentage of grade defects. Another objective was to determine the relationship of the results obtained from this method of grading to those obtained from the current method of grading tomatoes for manufacture of strained tomato products.

The 1954 study was conducted at two tomato products canning plants, one in Delaware and one in Ohio. Baskets of tomatoes were taken from farmers' loads as they were brought to the plants and graded in accordance with the U. S. Standards for Tomatoes for Manufacture of Strained Tomato Products. A defects grade was determined for the load on the basis of a three basket sample and objective color measurements were made on a subsample using the Hunter Color and Color Difference Meter, Purdue Color Ratio Meter and the Model F. Agtron. Subjective color determinations were also made by eye using the MacBeth-Munsell Disk Colorimeter for a constant light source. Deaeration studies were also conducted on the raw juice to determine the effect of air incorporated in the juice in preparing the sample for color evaluation.

The data obtained during the two months' investigations in the field are now being compiled and analyzed to determine the accuracy and dependability of the instruments used to evaluate tomato color as compared to visual color determinations. The performance of the Agtron and Color Ratio Meter, which are simple, rapid reading colorimeters are being evaluated. The importance of deaerating the raw juice will be determined. Finally the relationship between the proposed method for grading cannery tomatoes with the method now used will be studied.

Plans - It is planned to continue these investigations another year as the findings this year indicate that a better sampling device for selecting a relatively small sample of tomatoes for pulping must be perfected. The effects of deaerating raw juice on color improvement requires further study. Finally the relationship between the proposed grade and the present grade cannot be established until the sampling and color problems are solved.

- K. Proposal for Committee Consideration - Expand work on the development of objective quality tests and instruments for measuring quality of vegetables for the fresh market and for processing. Continue to evaluate colorimeters for measuring tomato color to perfect an accurate, yet simple, rugged instrument which can be used on grading platforms, in quality control laboratories or in the processing lines of canning plants. Develop a machine to rapidly measure the tenderness and maturity of individual units of peas, lima and snap beans, and asparagus which automatically records the maturity value for each unit. These values would then be electronically integrated to indicate the percentage of No. 1, 2 or 3 quality units present and would be punched or printed on a grade ticket. This machine would be superior to present tenderometers, shearpresses and maturometers which determine the average maturity or tenderness value for several to a few hundred units.

See also coordinate proposal under Utilization Research.

Publications

Objective Evaluation of Color of Tomatoes for Processing - A Report on the 1953 Studies to Develop a Method for Use in Inspection Procedure. D. E. Wilson and G. B. Dever.

Shear-test Measurements for Quality of Vegetables - The shear-test instrument, operated on a hydraulic principle gives a measurement of the force required to cut through vegetable tissue with a shearing tool. This instrument, in tests made last season, gave significantly different readings for celery, cabbage and lettuce stored at 32°, where they were held turgid and fresh, than when they were held at 38° where greater moisture loss took place. Comparative tests with the shear tester and the tenderometer made on peas in cooperation with the Wisconsin Agr. Exp. Station, gave comparable results, both closely correlated with the scores of judges for the quality of canned peas.

Plans - These studies on objective measurements of quality will be continued.

Publication

Comparison of the shear press and the tenderometer. K. G. Weckel, D. C. Kuesel, J. A. Stein and K. D. Demaree. Fruit Packer, Oct. 1954.

Objective Measurements of Color in Vegetables - Many fruits and vegetables undergo a change in color as they approach maturity and after they are harvested. A sufficiently sensitive, rapid, objective method of measuring these changes would be of considerable value in the study of pre-harvest and post-harvest behavior of fruits and vegetables and of the various factors that affect it. Studies are being made at Beltsville, Md. to determine how accurately these changes in color can be measured with the Hunter Color and Color-Difference Meter. Changes in the yellow color of maturing sweet corn could be measured. The ratio of color readings a and b ranged from .14 at the time the corn could be harvested with good quality to .25 when the corn was approaching the overmature stage. When the a/b ratio was plotted against the days from first silking a nearly straight line resulted. These results indicate that the a/b ratio may be of value in determining the maturity and thereby the grades of fresh corn delivered at canning and freezing plants. Readings on the flesh of individual sweetpotato roots failed to give a significant correlation with the carotene or the total carotenoids determined chemically on the same roots. See also report under Utilization Research.

Plans - These studies are being continued.

Effect of Temperature and Wilting on the Loss of Vitamin C in Vegetables - Studies at Beltsville, Md. on the effect of temperature and of wilting on the loss of vitamin C in vegetables show that both factors are important. Spinach, kale, turnip greens, rape, collards and snap beans were studied at 3 temperatures and at 3 degrees of wilting. A low temperature and a high humidity is most favorable for preserving a high vitamin C content. At low temperatures (32° - 33° F.) the ascorbic acid content may show an apparent increase because the leafy vegetables lose weight through loss of moisture more rapidly than they lose ascorbic acid, but at higher temperatures (50° and 70°) the tendency is to lose ascorbic acid more rapidly than moisture. As the vegetables lose their crispness, loss of ascorbic acid is accelerated. At 32° high humidity and no visible wilting evident (loss in weight 5%), kale lost 3% of its ascorbic acid in 5 days compared to 18% where appreciable wilting occurred (30-35% loss in weight). Kale held at 32° , 50° and 70° F. and high humidity for 2 days lost 2, 13 and 51% ascorbic acid respectively.

Plans - This work is to be continued and broadened to include provitamin A (carotene).

Effects of Storage Humidity on Vitamin C and Moisture Content of Sweetpotatoes - Orange Little Stem sweetpotatoes stored at Beltsville, Md. at 60° F. under 3 humidity conditions (95% plus 80-85% and 80-85% high air velocity 200 ft/min.) showed an increase in provitamin A (carotene) under all 3 conditions, the increase being progressively greater at the higher humidity. Ascorbic acid (vitamin C) decreased during storage and while the loss was slightly greater at the higher humidity the differences were of doubtful significance. At the highest storage humidity the roots increased in moisture content, the increase being statistically highly significant. No significant changes occurred at the lower humidity. Loss in weight after 6 months' storage was in inverse ratio to storage humidity and averaged 16.5, 21.5 and 22.4% respectively. Decay was also less at the highest humidity, and less in roots stored at 60° F. than in comparable roots stored at 55° . Readings made with the Hunter Color and Color-Difference meter on the flesh of individual roots did not give a significant correlation with the carotene or total carotenoid content as determined analytically on the same roots.

Work is in progress on a manuscript dealing with the physiological and biochemical effects of preharvest storage conditions on the post-harvest behavior of sweetpotatoes.

Plans - This work is being continued.

MARKET DISEASE IDENTIFICATION - MRD

Lettuce - Brown Spot - Brown spot which has caused some heavy losses on the market is not a specific disease, but a complex of at least 3 types of symptoms. The first is a midrib discoloration which is apparently physiological in nature and arises from adverse conditions during the growth of the lettuce and develops extensively during transit and storage. This has been observed in lettuce from the Imperial and Salinas Valleys of California, Arizona, Uvalde area of Texas, Florida, Georgia, Virginia, New Jersey, and South Carolina. The second type of brown spot is a leaf breakdown that develops in transit or storage and has been observed only in California and Arizona shipments. The third type is associated with leaf decay caused by the bacterial soft rot and gray mold rot organisms.

Plans - Further studies will be made on this disorder.

ANTIBIOTICS FOR DECAY CONTROL - MRD

Progress and Findings - 1954 Recommendation, "Expand research on antibiotics for decay control. (8/25)

No expansion was possible.

METHODS OF IMPROVING STORAGE BEHAVIOR - MRD

Progress and Findings - 1954 Recommendation, "Expand research on cold storage of vegetable seeds, plants and plant materials." (9/25)

No expansion was made.

Onion Curing and Storage Quality - Methods of forced-curing onions have been tested for several years at Harlingen, Texas, in studies cooperative with the Texas Agr. Exp. Station and the Refrigeration Research Foundation. The original purpose of the tests was to determine if the storage behavior of Bermuda onions could be improved by artificial curing treatments. Onions inoculated with the botrytis neck rot organism have been used the last two seasons to measure the effectiveness of the artificial curing methods. Granex and Excel onions were inoculated, subjected to forced-curing, and stored at 33° F. for 12 weeks plus a holding period of 2 weeks at room temperatures. The forced-curing treatments included either a 9-minute

exposure to infra-red light or 4 hours in a gas-fired dehydrator heated to 118°. The percentage by weight of sound Granex bulbs remaining in each treatment was as follows: (1) infra-red - 47%; (2) dehydrator - 28%; (3) checks - 1.3%. Comparable figures for the Excel lots were 34, 27, and zero percent respectively.

Plans - This work will be continued. Additional decay organisms will be used in inoculating the test bulbs. The possibility exists that with a still shorter treatment period infra-red drying might be utilized in the packing line during periods of inclement weather.

Sweet Potato Storage Factors

Effect of high moisture at harvest time - Eight periodic diggings made during the fall of 1953 at Meridian, Miss. (In cooperation with Vegetable Section of ARS) again produced evidence that killing of the vines by frost in no way influences keeping or culinary quality of sweetpotato roots. The data indicate soil moisture and temperature influenced both the buildup of respiratory substrate and composition of gases in the roots. Periodic analyses of the internal atmospheres show that oxygen dropped considerably and even disappeared at times during periods of rainfall, while carbon dioxide accumulated to very high levels. Roots dug with low oxygen and high carbon dioxide levels kept very unsatisfactorily. Oxygen content of the roots dropped during the first 2 to 3 days of curing. The lowest levels of oxygen during curing were highly correlated with poor edible quality and distinct pithiness if the roots kept.

Plans - This work is being pursued further with more nearly controlled moisture and temperature levels as well as again closely checking field conditions and subsequent changes in the roots.

Crate linings control humidity - Because of the frequent difficulty in maintaining high relative humidities in sweetpotato storage houses, work with crate liners was initiated in an attempt to overcome the disadvantages of low room humidities. A lining of manila paper kept relative humidities above 85 percent in the crate 2 to 3 days longer than when no liner was used in storage held at 60 to 70 percent relative humidity. A pliofilm liner (non-sealed) kept relative humidities above 90 percent in crates almost indefinitely, but caused too much condensation and sprouting.

Plans - This work is being continued this season.

Comparison of varietal keeping qualities - Porto Rico, Allgold, and Goldrush sweetpotato roots kept about equally well at both 60° and 70° F., while at 50° all three varieties kept poorly. Porto Rico and Goldrush were badly affected by internal breakdown at 50° but Allgold was only slightly affected. Poor keeping was associated with the accumulation of carbon dioxide and low reducing sugar values within the roots. Porto Rico roots sprouted slightly more than Goldrush in curing and storage and both sprouted considerably more than Allgold. This difference was reflected in plant production of bedded roots with Porto Rico yielding the greatest number of plants, Goldrush nearly as many, and Allgold considerably less. Roots of all 3 varieties stored at 70° were sprouted more after storage and produced more plants than those stored at 60°, while those stored at 50° produced few or no plants. For a second year roots that had long sprouts at bedding (about 2") produced more plants than roots with sprouts just showing. This was true whether the roots were placed in a heated, or non-heated bed. The differences were greatest during the first pullings. Sprouting the roots just prior to bedding was slightly better than sprouting them with a long cure. The treatments did not affect keeping quality significantly.

Plans - This work will be pursued further to explore the relationship between carbon dioxide accumulation and internal breakdown and respiratory activity of the roots.

Weight loss and decay - A very high positive correlation between weight losses from individual sweetpotato roots and subsequent decay during storage was obtained for the third season. It is likely that weight loss records will prove to be useful to storage house operators for estimating keeping quality (decay and pithiness) of Porto Rico sweetpotato roots.

Plans - This work is being concluded this season.

Sprout inhibitor sprays - In studies at Meridian, Miss. sprays of maleic hydrazide applied to the vines at 2500 to 5000 ppm 1 and 2 weeks before harvest greatly reduced sprouting on about 25 percent of the roots at the highest level of application. Such roots lost about 1 percent less weight during curing and storage of about 9 months than roots which were not treated. Sprouts amounted to about 2 percent of the root by weight, thus the total saving would be about 3 percent. Dry weight of treated roots averaged about 1 percent higher than check roots.

In studies at Beltsville, Md. preharvest foliar sprays had little if any visible effect on the foliage and no significant effect on the accumulation of carotenoid pigments in the roots during the interval between treatment and harvest. However, the treatment caused surface pitting of the harvested roots and seriously interfered with the normal synthesis of provitamin A (carotene) and other carotenoid pigments during storage.

Plans - No further work is planned.

Publications

Effects of temperature and soil moisture at harvest and delay in curing on keeping quality of Porto Rico sweetpotatoes by L. J. Kushman, M. T. Deonier, J. M. Lutz, and Belton Walters. Amer. Soc. Hort. Sci. 63: 415-419. 1954.

Effect of temperature and duration of storage on quality of stored sweetpotatoes, by J. S. Cooley, L. J. Kushman, and H. F. Smart. Economic Botany 8(1): 21-28. 1954.

A survey of internal cork of sweetpotatoes in Mississippi in 1952, by L. J. Kushman and M. T. Deonier. Plant Disease Reporter 37(12): 614. 1953.

Sweetpotatoes; physiological and biochemical effects of maleic hydrazide on pre-and postharvest behavior. Boyce D. Ezell and Marguerite S. Wilcox. Jour. Agri. Food Chem 2: 513-15. May 1954.

Effect of Storage Temperatures on Wastage in Lettuce, Celery, Cabbage and Tomatoes - Work was started at Beltsville, Md. under a contract with the Navy Department to study methods of storing lettuce, celery, cabbage and tomatoes for use of personnel on shipboard and at distant shore-bases.

Five shipments of lettuce in commercial vacuum cooled fiberboard packages were stored at 38° F., the usual temperature used by the Navy, and at 32°. A relative humidity of 90-95 percent was maintained at both temperatures. The amount of waste was determined at weekly intervals. After 6 weeks' storage the usual commercial pack held at 38° averaged only about 18 percent edible lettuce and that at 32° almost twice as much, about 31 percent. Lettuce trimmed before storage averaged about 7 percent more edible lettuce than the untrimmed lots at 38° and about 10 percent more at 32° at the end of 6 weeks' storage. There was slightly less waste in cartons lined with polyethylene than in unlined cartons.

Specially prepared cartons of lettuce shipped from Salinas, Calif. by co-workers at the Fresno, Calif. station, arrived in Washington in a commercial car of lettuce consigned to a local dealer. In this test 12 cartons were trimmed of all wrapper leaves which are usually left on and six of these cartons were lined with polyethylene film which was folded but not sealed, and 6 were left unlined. Another lot of 12 cartons similarly trimmed were prepared with the heads individually wrapped in cellophane. On arrival in Washington the test cartons along with check cartons from the same lot of lettuce packed in the usual commercial manner were divided and stored at 32° and 38° F. Before storage the only difference in appearance between lots was that the lettuce in the lined cartons had lighter colored butts.

After 6 weeks' storage all lettuce held at 32° was much better appearing and contained less waste than comparable lettuce held at 38°. The commercial pack stored at 32° contained 20 lbs. edible lettuce after trimming, the unlined field trimmed carton also had 20 lbs. edible lettuce while the lined carton had 24 lbs. of good lettuce. There was only 9 lbs. of edible lettuce remaining in the check lot stored at 38°, in the field trimmed lot there was 12 lbs., and in the lined lot 15 lbs. In general the commercial pack after 6 weeks' storage showed much slimy rot before trimming. The field trimmed lots were better appearing than the checks with less slime while the trimmed and lined lots were the best of all, still green and crisp, the butts were much lighter than the others and more edible lettuce remained.

Celery stored at 32° and 38° F. for 4 weeks had 20 percent more edible material remaining at 32° than at 38°. After 6 weeks' storage 40 percent of edible celery remained in 32° and none in 38°.

Early cabbage trimmed after 6 weeks' storage at 32° and 38° F. had 71 and 66 percent respectively of edible material remaining. At 32° the cabbage was greener and more tender as indicated by the shear-tester. At 38° the heads were slightly yellow and the leaves separated more easily from the stalks than at 32°.

Preliminary tests with locally grown, freshly harvested tomatoes indicated that vine ripened tomatoes are easily bruised in harvesting and handling and when stored at 38° F. (ship storage temperature) became water-soaked, lost flavor, and deteriorated in 14 days. Fruits harvested mature-green and held at 38° developed chilling injury when held 15 days or longer and when placed at 65° to ripen developed 100 percent alternaria rot. Fruits harvested mature-green ripened in 12 to 14 days to firm ripe condition at 65° and then stored at 38° remained in satisfactory condition for an additional 18 days. Thus a storage life of 30 to 32 days was realized.

Plans - Further tests are planned with tomatoes from several major producing areas, and with other ripening and storage temperatures. Storage tests on lettuce, celery and cabbage will be continued.

INSECT CONTAMINATION OF PROCESSED VEGETABLES - ENT

Progress and Findings - 1954 Recommendation "Expand research on the nature and status of insect contamination problems of importance to the processors of vegetables and fruits and to develop methods for their solution." (10/25)

No expansion was made.

Approximately 21 processing plants in the Pacific Northwest and in the San Francisco, California area were contacted to determine what are the most important insect-contamination problems in relation to vegetables to be processed and to find out what methods, if any, are in commercial use to alleviate them. Processors in these regions reported that their most important insect-contamination problems are as follows: aphids on spinach, brussels sprouts, and broccoli; Drosophila in tomatoes; and thrips on asparagus. Less important problems are caterpillars on broccoli; aphids on cauliflower; asparagus beetle eggs and ladybird pupae on asparagus; alfalfa looper and seedcorn maggot on spinach; corn earworm on ears of sweet corn; tomato fruitworm in tomatoes; carrot rust fly in carrots; and Drosophila adults in processing plants for tomatoes. A similar survey in eastern Maryland showed the following insect-contamination problems to be currently most important; sap beetle and European corn borer larvae in ears of sweet corn; asparagus beetle eggs on asparagus; aphids and caterpillars on broccoli; and Drosophila eggs and larvae in tomatoes.

Exploratory tests on a small scale were conducted in a corn canning plant in eastern Maryland with the objective of developing a wash for the removal of sap beetle larvae from sweetcorn ears. Six dilutions of pyrethrum alcohol extract, 0.0025 to 0.1 percent pyrethrins, were tested in combination with an emulsifier. Promising results were obtained with washes containing 0.04 percent of pyrethrins plus 0.02 percent of Triton X-100 and 0.02 percent of pyrethrins plus 0.01 or 0.02 percent of Triton X-100. A 3-minute soak in these mixtures removed an average of 93 and 98 percent, respectively, of the larvae.

Approximately 145 materials, including 103 chemicals, were tested in the laboratory in Maryland as attractants for Drosophila adults. The objective was to find some material more attractive than tomato to adults of this insect that can be combined with an insecticide and used in the field as a bait. Some of the fermented solutions containing yeast, such as unsulfured molasses, Karo Syrup, granulated sugar or brown sugar solution, apple, grape, or tangerine juice and apricot nectar, were promising and were definitely more attractive than ripe tomato. None of the chemicals tested were entirely satisfactory.

In Utah, two applications of a bait with molasses and yeast as the attractant and aldrin as the toxicant, on a vermiculite base, was superior to dust applications of aldrin and malathion for reducing Drosophila breeding in a tomato field. Malathion dust applications gave some indications of attracting the vinegar nat in the plots. Under laboratory conditions in Maryland, a bait prepared by saturating vermiculite with a formulation of chlordane emulsion, fermented unsulfured molasses dry yeast and water gave a 97 percent kill of caged Drosophila adults in 24 hours.

Under laboratory conditions in Utah, applications of aldrin, malathion and chlordane dusts and sprays killed nearly 100 percent of Drosophila adults. Dieldrin, lindane, endrin, isodrin, parathion and pyrethrum applications were effective against Drosophila adults but not very effective against the larvae. DDT, heptachlor, BHC and toxaphene gave poorer results.

Laboratory tests were continued in Maryland on the development of a wash for use in processing plants for the removal of asparagus beetle eggs from harvested asparagus. Of approximately 200 wash formulations tested, 17 removed 75 percent or more of the asparagus beetle eggs and 8 removed 80 to 85 percent of the eggs and did not cause detectable phytotoxic injury to the edible spears of asparagus. A water wash, functioning as a check, removed only 21 percent of the eggs.

Plans -- Investigations will continue on (1) determining the insect-contamination problems of importance in vegetable-processing plants; and (2) the development of methods for removing aphids, caterpillars, and other insects and insect debris from leafy vegetables, European corn borer larvae and sap beetle larvae from the ears of sweet corn, Drosophila eggs, larvae and adults from tomatoes, and asparagus beetle eggs from asparagus prior to processing.

Publications

Drosophila control. H. E. Dorst and G. F. Knowlton. Extension Cir. 216, Utah State Agr. Col.

PHYSIOLOGY OF STORAGE AND RIPENING - MRD

Progress and Findings - 1954 Recommendations "Expand studies on post harvest physiology of fruits and vegetables." (12/25)
Substantial expansion was made by employment of 3 professional employees.

Tomato Respiration and Volatile Production During Ripening. A study of the physiology of tomato ripening was continued. Respiration, ethylene production and the emanation of odorous volatiles were measured on mature-green tomatoes ripened at 65° and 85° F. and those ripened at 65° after storage for 4, 8, or 12 days at 35°. Ethylene production at 85° is normal although lycopene formation is somewhat retarded. Mature-green tomatoes upon removal from storage at 35° show a burst of respiration at 65° or 70°. The burst in respiration as measured on small fruits in a Warburg apparatus was much more pronounced with immature than mature fruits and was the lowest for fully-ripe tomatoes. Additional work is required to determine if there is a concomitant burst in ethylene production and emanation of odorous volatiles under these conditions. Tomatoes ripened at 65° and 85° exhibit first a respirational climacteric, then a climacteric in ethylene production and finally a climacteric in the emanation of odorous volatiles that attains a peak with the breakdown of the fruit. Additional work is required to delineate the respective climacterics in fruit previously stored at 35° for 4, 8 and 12 days before removal to 65° for ripening.

Plans - These studies will be continued. See proposal for expansion of physiological studies.

Publications

Physiological studies of mature-green tomatoes in storage. C. C. Craft and P. H. Heinze. Submitted Proceedings American Society Horticultural Science.

Light Required to Develop Tomato Color - It has been found that supplying a small amount of light during the ripening of certain varieties of tomatoes harvested in the mature-green stage affects their appearance by causing the development of a yellow pigment in the outer cuticular layer of the skin of the fruit. The pigment is absent in the skin of tomatoes ripened in total darkness which causes the ripe fruit to have a pink color instead of the characteristic orange-red color of tomatoes ripened in light. Cooperative investigations with the Basic Studies of Plant Growth and Development Unit, ARS, have shown that the quality and quantity of light required to produce the

pigment is very similar to the light required to regulate the flowering response of certain plants and the germination of some seeds. Identification of the types of compounds responsible for this reaction to light may increase the understanding of certain phases of the physiology of these plants.

Plans - These studies will be continued.

Publications

A. A. Piringer and P. H. Heinze. Effect of light on the formation of a pigment in the tomato fruit cuticle. Plant Physiol. In Press.

Factors Affecting Moisture Loss from Fruits and Vegetables - Work has been started on the various factors that bring about moisture loss from fruits and vegetables. The factor under study at present is relative humidity of the air. One of the major troubles in obtaining such data is the difficulty of measuring humidity accurately at the comparatively low temperatures at which most fruits and vegetables are stored. In the work at Beltsville two different types of hygrometers are used. These are checked frequently against each other and also against a wet and dry bulb thermometer.

The tests have so far covered only a few commodities but some interesting results have been obtained. A wide variation was found in the rate of moisture loss between various products and in some cases between different varieties of the same commodity. The rate of loss per unit of vapor pressure deficit is not constant except for the loss of small amounts of moisture. As the total loss increases the loss per unit of vapor pressure deficit decreases very markedly. This is probably caused by physiological or physical changes in the fruit which interfere with moisture travel through the cells at a rate sufficiently rapid to maintain a saturated atmosphere in the air immediately in contact with the surface of the fruit.

The data on the commodities which have been tested are as follows:

<u>Product</u>	Loss Mg./Kg/Hr./MM of Vapor Pressure Dif.
Apples, Jonathan	20-25
Apples, Grimes Golden	40-60
Apples, Golden Delicious	50-90
Peaches	300-1000
Tomatoes, Mature green	50-175
Squash, summer	800-1700

In the above data the range of values given represents data obtained either at 32° or 40° F. (or both) and at relative humidities of approximately 75, 85 and 95 percent. The low values were obtained at vapor pressure deficits which are usually about 0.25 mm and the high values at deficits of about 1.35 millimeter. The results at relative humidity of 85 percent (VP deficit about 0.80) were intermediate between the two.

Plans - These studies will be continued.

Enzymatic Studies of Vegetables after Harvest - One of the advances in the field of biochemistry in recent years has been the demonstration that something that may well be the "respiratory mechanism" of the cell can be isolated and studied in vitro. This "respiratory mechanism" is a group of cellular particles, previously identified morphologically as mitochondria, which contain all the enzymes, in integrated form, that can carry out the oxidation of organic acids of the citric acid cycle (the cycle associated with respiration). This work is only in its beginnings and has been demonstrated for the most part with animal tissues. However, mitochondria have also been isolated from plant tissues and the implications of such studies are far-reaching with respect to basic understanding of biological processes. The purpose of the work is the characterization of the cellular particles which contain the major portion of the respiratory mechanism of fruits and vegetables. This essentially involves taking apart the machinery of the cell and attempting to analyze the components. The ultimate goal is to obtain basic information on the aging of tissue which will allow the development of better techniques for the handling, storage and transportation of fruits and vegetables. The specific problems under study in cooperation with the University of California at Los Angeles are:

- 1) Methods of isolation of mitochondria from broccoli buds and sweetpotato.
- 2) Requirements of the mitochondrial enzyme system after isolation as judged by its oxidizing ability.
- 3) Types of substrates oxidized.
- 4) Stabilization of oxidative ability and mechanism of stabilization.

The following results were obtained from the first years work:

- 1) A mitochondrial enzyme system was isolated from broccoli buds and sweetpotato tissue.

2) This mitochondrial system had the ability to oxidize substrates of the citric acid cycle.

3) All substrates of the citric acid cycle were not oxidized to the same degree. Succinic acid was oxidized to the greatest degree, α -keto-glutaric acid was very poorly oxidized, while pyruvic acid was hardly oxidized at all.

4) The oxidative ability of the mitochondrial enzyme system was stimulated and stabilized by the chelating agent ethylene diamine tetraacetic acid.

5) The beneficial effect of ethylene diamine tetra acetic acid appears to be due to the chelation of some inhibiting cation or cations.

Plans - The work is being continued along the following lines:

1) Determination of the inhibiting cation or cations in isolated mitochondrial systems.

2) Determination of the reasons for the variability of tissue with respect to stimulation and stabilization by ethylene diamine tetra acetic acid.

3) Factors involved in the oxidation of pyruvic acid.

4) Studies on the enzymatic makeup of the mitochondrial system.

5) Relationship of the activity of mitochondria to aging or deterioration of fruit and vegetables with handling and storage.

- L. Proposal for Committee Consideration - Expand basic research on the physiological disorders that cause spoilage and loss of quality in vegetables after harvest. Specific problems to be studied are the processes involved in yellowing of green leafy vegetables, brown spotting of lettuce, brown discoloration of carrots, and chilling injury at temperatures above freezing and the effect of ethylene and other volatiles liberated by the stored products.

COMMERCIAL RIPENING OF TOMATOES WITH ETHYLENE - MRD

In a continuation of work reported last year with Florida tomatoes, it was found that the ripening period of mature green tomatoes from both Texas and Florida was shortened by 1 to 2 days by treatment

with ethylene. On the other hand tomatoes which were near the turning stage (about 4 days from ripe) when treated were benefited but little. These results suggest that ethylene would be of benefit only to tomatoes that would normally require 7 or more days to ripen normally.

Plans - This work is completed.

Publication

Commercial aspects of ripening mature-green tomatoes with ethylene gas, by W. A. Radspinner submitted to Pre-Pack-Age.

IMPROVE SAMPLING METHODS USED IN INSPECTIONS OF FRESH AND PROCESSED FRUITS AND VEGETABLES - FV

Progress and Findings - 1954 Recommendations, "Initiate a study of sampling methods used in the inspection of fresh and processed vegetables to devise improved procedures were practicable." (13/25 Res).

A modest beginning of work on this problem has been made during the past year. Some basic data have been collected on the variation in quality that exists in individual lots of certain fresh and processed fruits and vegetables and this work is continuing. In addition, analyses have been initiated of the conditions under which inspections must be conducted.

Plans - During the initial phase of the study the statisticians assigned to this work are acquiring background information on the whole range of fruits and vegetables, becoming thoroughly familiar with all aspects of inspection procedures and with the various methods followed in handling, packing, and processing. The next step will be intensive studies confined to one commodity or a small group of related commodities at a time since there are wide differences between the methods followed in packing and handling different fruits and vegetables and between different plants handling the same commodity.

- M. Proposal for Committee Consideration - Expand the study of sampling methods used in the inspection of fresh and processed fruits and vegetables to devise improved procedures where practicable. This represents a major and continuing problem in the inspection of fruits and vegetables. Not only does it involve the adequacy of the size

of sample and its design and selection; also concerned are questions of measuring specific grade factors, the application of limiting rules in the standards, the use of statistical quality control techniques in plants under continuous inspection, and the revision of grade standards in the light of modified inspection procedures. Since the approach to improve sampling and inspection procedures must be largely a commodity-by-commodity basis, it is highly desirable that a greater amount of effort be devoted to this problem than is possible at the present time.

RELATIONSHIP OF THE QUALITY AND YIELD OF PROCESSED VEGETABLES TO
THE QUALITY OF THE RAW PRODUCTS - MRD (Matched funds)

Progress and Findings - 1954 Recommendation, "Expand work on relationship of raw product quality to the quality of processed products to include further work on sweet corn and peas and start work on lima beans and asparagus." (20/25) No expansion possible.

Peas - The grade relationship study on peas for processing conducted in cooperation with the Wisconsin Agricultural Experiment Station was completed during the 1954 pea canning season. This year's data are being combined with that of the previous two years and a final report on the three years' work is being prepared for issuance in the spring of 1955.

Plans - Additional work is proposed to determine the effect of grade of raw peas to the yield of canned peas of different grade classification.

- N. Proposal for Committee Consideration - Initiate a study to determine the effect of a quality grader on the yields of various grades of peas for canning. There is a very distinct difference of opinion voiced by pea processors as to the relative merit and advantages of quality grading of peas in processing. Some processors feel that it is both practical and economical to quality grade peas using a brine quality grader while others contend that they are neither practical nor economical to use. To our knowledge there is no published data on the effects of the values of quality grading in the fractionation of peas or upon their subsequent marketing value. It is proposed to conduct this research on a matching fund basis in cooperation with the Wisconsin Agricultural Experiment Station for three reasons: (1) Some Wisconsin pea canners have requested the Wisconsin Station to conduct this work, (2) The Wisconsin Station is qualified to do this work as they have the personnel available and pea processing facilities, (3) Wisconsin packs between 40 and 45% of the canned peas packed in this country every year, packing more than twice as much as any other state.

Corn - A study of the relation of yield and quality of canned and frozen corn to the quality of the raw sweet corn was continued in 1954 in cooperation with the Ohio Agricultural Experiment Station. The work was conducted at a pilot plant at Ohio State University in Columbus, Ohio. Two varieties of sweet corn from each of four plantings were harvested at four different stages of maturity. Each harvest was divided into lots and processed into (1) canned whole grain corn, (2) canned cream style corn, (3) frozen whole grain corn, and (4) frozen corn on the cob.

The raw corn was graded by a Federal-State inspector in accordance with the U. S. Standards for Sweet Corn for Canning. Objective quality tests were made on the raw corn such as moisture content by vacuum oven method and Steinlite Moisture Tester, soluble solids, alcohol insoluble solids, percent pericarp, succulence with the Succulometer, and kernel size. The canned and frozen products were graded on the basis of the U. S. Standards for canned and frozen products. The same objective quality tests were made on the processed corn as on the raw corn. The data from the first two years' work are being compiled and analyzed. In 1954 data were also obtained at a commercial corn canning plant and the product analyzed by both subjective and objective methods at various stages of the process from the raw product to the finished product.

Plans - It is planned to continue the corn grade relationship study for one more year repeating the pilot plant experiments and expanding the work in the commercial plant by either obtaining data on more daily runs at the one plant or obtaining data at an additional corn canning plant in Ohio.

- O. Proposal for Committee Consideration - Expand the work on the yield and quality of canned and frozen sweet corn in relation to raw product quality to another state such as Maine, New York, or Wisconsin after the various objective quality tests used in the Ohio project have been evaluated. It can then be determined which of these tests, either separately or in combination with others, can be used for accurate evaluation of tenderness and maturity in sweet corn in lieu of the subjective tests presently used in grading fresh and processed corn in accordance with the U. S. Standards.

LOADING METHODS ON DAMAGE TO WATERMELONS - MRD

Watermelon shipping tests in 1954 were limited to a comparison of the crosswise and lengthwise methods of loading. Crosswise loads were tested for the first time in 1953.

The 1954 shipping tests were started near Leesburg on May 10 and due to drouth effects were terminated at Fairfax, South Carolina, on July 14. Forty-three cars were loaded crosswise in Florida, 11 in Georgia and 14 in South Carolina, making a total of 68 cars loaded crosswise, and a similar number of cars loaded in the conventional lengthwise manner served as checks. Outturn reports were received on only 59 cars of each method of loading. In the crosswise loads there was a 60 percent reduction in cracked melons, 68 percent reduction in bruised melons and 65 percent reduction in total transit damage other than decay as compared with lengthwise loads. The difference in decay between the 2 types of loads was negligible. These results are closely parallel to those of 1953.

Some crosswise loads were made with one row of melons placed lengthwise of the car to make a tight load. When these loads were compared with loads in which all melons were loaded crosswise it was found that the amount of visible damage was considerably greater in the cars with the lengthwise rows.

Flesh damage increased with advancing maturity and was more prevalent in the shipments from South Carolina than in those from Florida.

Plans - Further tests are not contemplated for the coming season. This work is finished.

Publications

Crosswise loading of long watermelons - a means of reducing damage during transit, by J. R. Winston, P. L Breakiron and J. Kaufman, Agricultural Marketing Service, U. S. Department of Agriculture. 1953.

Studies of watermelon loading (published as Marketing Research Report No. 62, May 1954) by P. L Breakiron, Transportation and Facilities Branch, and J. R. Winston and J. Kaufman, Biological Sciences Branch, Agricultural Marketing Service.

A paper on two seasons' results entitled The Crosswise Method of Loading Long Watermelons Reduces Transit-Connected Damage, presented at the Florida State Horticultural Society meeting, October 1954.

FREEZING POINT DETERMINATIONS ON FRUITS AND VEGETABLES - MRD

In response to recommendations of the Cold Storage Advisory Committee work was renewed on freezing points of fruits and vegetables. A recording potentiometer was used to follow the temperature drop and rise when freezing occurred. Freezing points were determined the past season for 7 varieties of sweetpotatoes, 8 varieties of potatoes, and also for 10 lettuce varieties each of which was grown in the field and in the greenhouse. Eighty-five freezing point determinations were made on 50 other species of fruits and vegetables as well as 35 additional ones on varieties of these.

Determinations of freezing points for a few of the more important vegetables will be checked for differences due to growing season and locality where grown. It seems even more important to know the possible range of maximum freezing points for each commodity and each variety. For the 6 varieties of apples studied the maximum freezing points ranged from 28.3° to 29.0° . For the 7 varieties of sweetpotatoes studied, the range was from 28.4° to 29.4° and in potatoes 29.1° to 30.8° . Thus, the evidence seems to indicate that the temperature at which freezing injury may occur varies considerably with variety. Previous storage treatment also affected freezing temperature. Three varieties of potatoes stored for several weeks at 35° F. and 40° had maximum freezing points of 29.1° , 29.3° , and 29.4° . The same varieties from identical lots held at 55° for the same period had maximum freezing points of 30.1° , 30.8° , and 30.2° , respectively. Whether these responses were entirely due to the accumulation of sugars at the lower temperatures as compared with little or no increase in sugars at 55° was not determined. Among several other commodities there was some evidence to show that merely storing the products for just one day at 32° lowered their freezing points as compared with specimens not subjected to such a low temperature. In these cases it is doubtful that changes from starch to sugar could have been sufficiently rapid to cause a lowering of the freezing points.

Plans - These studies will be continued.

TRANSPORTATION, FACILITIES AND PACKAGING

PREPACKAGING -- MRD

Progress and Findings - 1954 Committee Recommendation, "Expand work on prepackaging fresh vegetables." (1/25)

Research on prepackaging of carrots is under way under contract with the Western Growers Association. They have completed comparative sales tests of bunched fresh carrots and prepackaged carrots in six self-service food stores in the cities of New York, Boston, Detroit, Grand Rapids, Chicago, and Los Angeles. Preliminary data indicate that in many of these stores the bunched carrots actually outsold the prepackaged carrots, although in some stores the reverse situation was found. Many retailers were found unwilling to try out such tests because they had adopted a policy of retailing only prepackaged carrots in their stores.

In a companion study made by Department workers in eight stores located in New York, Boston, Grand Rapids, and Detroit, it was found that (1) bunched carrots accounted for 52 percent of total carrot sales when bunched and prepackaged carrots were displayed side by side with the prepackaged carrots priced, on the average, 13 percent higher than the bunched carrots; (2) cost of retailing bunched carrots was substantially greater than prepackaged carrots, amounting to 14 and 2 cents per sales dollar, respectively; (3) waste and spoilage losses amounted to 8 percent for bunched carrots as compared to 1 percent for prepackaged carrots; and (4) direct retail labor expense was 5 cents per sales dollar for bunched carrots as compared to 1 cent per collar for the prepackaged carrots.

In a trade preference survey, conducted by the Western Growers Association under contract with the Department, corporate grocery chain stores estimated that over 80 percent of their carrot sales were prepackaged carrots and service wholesalers estimated that over 90 percent of carrot sales in retail stores serviced by them were prepackaged. Surveys of the comparative efficiency of alternative methods of prepackaging carrots are still under way by Western Growers Association.

A report on prepackaging lettuce by retailers was prepared and published, although no additional studies on prepackaging of lettuce were made during the last year.

Plans - Studies are now being initiated to survey the use of various methods, types of machinery and equipment and types and sizes of packages that are being used by prepackagers for each of the important vegetables in all important producing centers and terminal markets.

- P. Proposal for Committee Consideration - Accelerate expansion of research work on prepackaging fresh vegetables. There is need for more research to develop suitable packages and methods of prepackaging a number of vegetables, including lettuce, green beans, celery, peppers, and root crops, as indicated by requests for information on how and where to prepackage vegetables, what types of packages are the best and cheapest, and what types of equipment and machinery are the most efficient, particularly at the shipping point level, and by terminal prepackagers and/or by service wholesalers.

Publications

"Prepackaged Lettuce is Preferred, But -," Marketing Activities, February-March 1954, by Donald R. Stokes and Russell L. Hawes.

"More than One Way to Package Produce" - United Merchandising Institute - Fresh Forum, Vol. V, No. 12, March 1954, by Donald R. Stokes.

"Packaged Produce -- Progress and Problems," published by The United Fresh Fruit and Vegetable Association, by Donald R. Stokes.

"Prepackaging Broccoli at Point of Production in Florida" - in process. R. K. Showalter, et al, Fla. Agr. Exp. Station Bulletin

$\frac{1}{4}$ "Prepackaging Cauliflower at Point of Production in Florida" - in process. A. H. Spurlock, et al. Fla Agr. Exp. Station Bulletin

IMPROVED OR NEW SHIPPING CONTAINERS - MRD

Progress and Findings - 1954 Committee Recommendation, "Expand studies on the development and evaluation of cheaper and improved shipping containers for vegetables." (3/25)

Work was completed and a report is in process of publication on a comparative study of the cost of packing and shipping lettuce in fiberboard cartons and wooden crates. The work was done under contract with the Western Growers Association. It was found that the cost of shipping fiberboard containers packed in the field and vacuum pre-cooled for shipment, averaged 25 cents lower per 4 or 5 dozen crate when shipped from the Imperial Valley of California, and 45 cents

lower per crate when shipped from the Salinas area than wooden crates packed in sheds, the latter ice-packed and shipments top-iced in the car. Condition tests made by U. S. Department of Agriculture inspectors at destination also indicated approximately 70 percent less bruising and decay of lettuce when shipped in fiberboard cartons upon arrival at the destination market, and 50 percent less after the lettuce was held 48 hours after arrival at temperature averaging about 70 degrees.

A reduction in the cost of marketing western cauliflower in eastern markets through closer trimming, which permitted the packing of twice as many heads in a crate only slightly larger than the one now in use, was found feasible in a study, also under contract with the Western Growers Association, completed during the year. During the time the study was under way the wholesale price of California cauliflower in the New York market was lower than it had been 10 years before, while the costs of containers had risen 65 percent, packing labor 97 percent, transportation charges 29 percent, and refrigeration costs 32 percent. During the intervening period the volume of western cauliflower sold in the New York market declined substantially. A report is in the process of publication.

A research contract was negotiated with the Western Growers Association for the evaluation of various containers now being used by the lettuce industry. A total of 300 carloads of lettuce shipped in various containers are being inspected in terminal markets. At least 50 carloads will be inspected for each of the most commonly used containers. During the past year, lettuce shippers found increasing demands for fiberboard containers and only a small fraction of the western crop is now being shipped in wooden crates.

Studies to evaluate new and improved types of shipping containers for tomatoes are under way. Tests are being made of several different types of fiberboard shipping containers for tomatoes, one of which is a dual-purpose shipping container which can also serve as a master container for prepackaged tomatoes.

Plans - Research on lettuce and tomato containers and the suitability of alternative loading patterns and devices will be continued. Test shipments of tomatoes from California in the fall of 1954 will be followed by similar studies of Florida and Texas shipments in 1955. Further study should be given to the development of a container for close-trimmed cauliflower that would be more economical than the wooden crates now in use.

- Q. Proposal for Committee Consideration - Accelerate expansion of studies on the development and evaluation of improved and cheaper shipping containers for vegetables. Fiberboard, laminated paper veneer and wirebound containers as well as multi-wall wet strength paper shipping bags, all offer promising prospects of reducing costs of containers for fresh vegetables. The use of fiberboard boxes for melons has been experimented with in pilot scale tests and possibilities of developing cheaper and improved containers for cauliflower, broccoli and celery need to be explored. There is a steady trend toward the use of more economical materials in packaging, but the development of new and cheaper containers is limited by problems of trade acceptance, loading patterns and methods, refrigeration and protection against damage in transit.

Publications

"Packing and Shipping Lettuce in Fiberboard Cartons and Wooden Crates - A Comparison" - P. L. Breakiron USDA Marketing Research Report

"Cutting Cauliflower Shipping Costs " - Marketing Activities, March 1954, John C. Winter.

"Potential Savings by Shipping Cauliflower in Double Layer Packs" - John C. Winter and B. P. Rosanoff, AMS T-1 USDA

IMPROVED CONTAINERS AND PACKAGING - FS

Progress and Findings - 1954 Recommendation "Expand Studies on the development and evaluation of improved and cheaper shipping containers for vegetables." (3/25)

Funds not available for expansion.

Treatments of agricultural and other containers with oil and water-borne chemicals, now in progress for 4 years, show that good protection against decay, stain, and mold seems practical with a simple surface treatment. Among the promising solutions are cheap water-borne chemicals and certain combinations of these chemicals with water-repellent wax emulsions. The treatments are aimed at lengthening the service life for picking boxes used in harvesting fruit and vegetables and to protect other containers under severe field conditions. The most promising treatments, which included water repellents, also helped to keep box weight low by reducing rainwater pickup in the field.

Many organizations have in recent years adopted wood pallets for the more efficient storing, handling, and shipping of commodities. A Laboratory publication outlines the development of the pallet industry and summarizes designs and specifications, presents results of research, and includes a glossary of terms and a selected bibliography. The results of several Laboratory testing programs are incorporated in this report. The data supplied have been a factor in increasing the annual use of the lower grades of lumber to over $1\frac{1}{4}$ billion board feet in recent years.

After tests on numerous materials, the Laboratory has found that a sandwich of four alternate layers of polyethylene film and kraft paper shows excellent promise as a satisfactory case-liner material to replace asphalt or wax-laminated kraft paper as a water-repellent liner for wood boxes. The latter materials have proved unsatisfactory in many boxes because of their brittleness when cold, since they may crack and admit moisture.

Drum and diagonal compression tests of boxes using paper-overlaid $1/8$ inch Douglas-fir veneer with light to medium degree of white-pocket indicated it was satisfactory as box material for shipping and storing of apples.

- R. Proposal for Committee Consideration - Expand research on new and improved materials for shipping containers and on the development of basic design data and performance standards for containers of various types. Cooperative work with industry and the Armed Services in packaging has resulted in the accumulation of much technical knowledge applicable much more generally than to the immediate projects for which it was done. This will be generally helpful in the urgently needed program of research on agricultural and related packaging and shipping problems. Specific lines of work would include (1) low-cost lumber from unpopular species for containers, including determination of how it can be used without excessive splitting, seasoned without inordinate warping and swan, sliced or otherwise machined rapidly, (2) pallets for farm crops and basic principles of pallet design, (3) design and performance standards for wood containers with special emphasis on use for agricultural products, (4) basic design data for use of fiberboard containers and their use for such agricultural products as vegetables, fruit and eggs, (5) evaluation of paper-overlaid veneer containers for nailing properties, gluing requirements, strength and serviceability for the agricultural container market, (6) design data for various materials for shipping drums,

(7) design criteria for cleated panel boxes, (8) containers for storage of fruit, vegetables and other food stuffs need to be designed for use under refrigerated and other storage conditions and for bulk handling equipment, and (9) special treatments for paper and paperboard to improve wet and dry strength in container use.

Plans - Work will be continued during the coming year on fruit and vegetable containers, pallets, fiberboard boxes and crates.

Publications

The Wood Pallet Industry, Its Development and Progress Toward Standardization. Forest Products Laboratory Report No. 1957, 1953.

TRANSPORTATION OF FROZEN FOODS BY MOTORTRUCK - MRD

Progress and Findings - 1954 Committee Recommendation, "Expand work on the testing of equipment and improvement of transit refrigeration of frozen food in motortrucks, trailers, and refrigerator cars." (11/25)

During the year consulting advice has been given the manufacturer of a dry ice system of refrigeration utilizing a secondary refrigerant which shows promise, for the correction of certain deficiencies in the operation of the equipment. One road test of the improved equipment was made from Boston, Mass. to Chicago, Ill. in which the average product temperature at the time of loading was -9.4° , with the thermostatic control set at -10° . Upon arrival at destination the product temperature averaged -8.8° , a good performance. Further tests of this unit are planned to study its operating efficiency under various ambient temperature ranges and the consumption of dry ice under different conditions. Although up to this time the cost of dry ice has limited its wide use, operating failures of mechanical units are frequent with consequent delays and resort to dry ice supplement to hold product temperatures. Maintenance costs are generally high. For these reasons operators of frozen food transport companies are dissatisfied with the present mechanical equipment, and are seeking positive refrigeration such as is provided by dry ice which will not be too expensive. An interim report is in preparation.

Because of the importance of adequate circulation of cold air around and under frozen food cargo, and the disadvantage of weight in wooden floor racks in motortruck-trailers, two types of aluminum floor racks have been developed and given preliminary road testing, with favorable

results. The lightest of these racks, in 35 foot trailers, in divided sections hinged to the side walls, weighed only 240 pounds. Further tests are planned. A report of the preliminary tests is being prepared.

Plans - Work on this project has not been expanded up to this time but with the addition of an engineer some expansion will be possible during the remainder of the fiscal year. Plans for the near future include the completion of negotiations for a contract with a commercial research firm for the study of the problem of moisture infiltration into wall, floor, and ceiling of trucks and trailers, with consequent added vehicle weight and loss of efficiency of the insulation.

Exploration will be made of the possibilities of a trailer body of plastic construction with the insulation molded into the walls, floor and ceiling, which would provide a lightweight, moisture-proof van. Arrangements have been made for participation in the design and development work with a manufacturer who has successfully developed a tank truck of this construction.

Plans are being developed for the expansion of work into the delivery of frozen foods from wholesale warehouses to retail stores. Because of frequent stops for delivery, holding low temperatures in these vehicles is a problem of much concern to distributors and delivery truck body manufacturers.

A comprehensive test of the adequacy of transit temperatures and the efficiency and fuel consumption of several types of mechanical units used in railroad refrigerator cars is planned, in cooperation with the Biological Sciences Branch, to be carried out in the summer of 1955.

Publications

Led panel discussion on truck refrigeration and air circulation, Truck Trailer Manufacturers Association, Boca Raton, Fla., January 1954. Harold D. Johnson

Guides for Shipping Frozen Foods by Truck, by Harold D. Johnson, T&FB-AMS, Quick Frozen Foods, Feb. 1954

How to Haul Refrigerated LTL Shipments, Fleet Owner, September 1954

Attended and participated in discussion on frozen food transportation by railroad and motor truck National Association, Frozen Food Packers Association, New York City, February 1954.

Participated in a panel discussion on transportation refrigeration and truck-trailer construction, Milk Industries Foundation, October 1954.

DEVELOPING BASIC DATA FOR PLANNING WHOLESALE PRODUCE MARKET
FACILITIES - MRD

Progress and Findings - 1954 Committee Recommendation, "Expand research to develop basic data for planning wholesale produce market facilities in specific localities." (15/25)

Personnel were not available to expand this work.

A manuscript covering designs of store buildings for produce wholesalers, sales sheds for farmers and truckers, and other types of facilities usually constructed on wholesale produce markets is being reviewed for publication. This manuscript should serve as a manual for market planners.

In November 1952, in cooperation with The National Association of Produce Market Managers, a study was initiated to obtain data on the operations of markets of various sizes and types. This study was completed during the 1954 fiscal year. Some 45 wholesale produce markets were visited and detailed analysis was made of the management, operating expenses, and income. A report on this work is in process. The results of this study should help market managers to find ways of reducing operating expenses, increasing income, and to do a better job of managing their markets.

During the current fiscal year, work was started on revising a manuscript on types of ownership and methods of financing wholesale produce market facilities. This manuscript started in July 1950 is being brought up to date and otherwise revised to allow for publication early in 1955.

The principles of desirable ownership of a produce marketing facility will be enumerated and different types of ownership will be appraised in light of these principles in an effort to provide a guide to the selection of the type or combination of types best suited to a specific market.

The report will appraise the several types of market ownership, defining each type, giving advantages and limitations of each, showing examples, and outlining processes of organization, requirements for organization, description of enabling legislation needed, etc. Included in the appraisal will be ownership by private corporations, combinations of corporations, public benefit corporations, state-owned markets, municipal markets, cooperatives, etc.

Types of items that should be financed by a market will be discussed, and a detailed description of how markets can be financed will be included in the study. Also to be discussed will be a classification of investors, where funds to finance markets can usually be found, and types of financial instruments usually used in the financing of a market facility.

See also report under Service Work of USDA.

Plans - Work in this general area will be continued and should be expanded.

- S. Proposal for Committee Consideration - Expand research to develop basic data for use in planning wholesale produce market facilities in specific localities. Such research should include work on: (1) Improved layouts and designs for various types of market structures; (2) amount of space required in various types of market structures in relation to volumes handled; (3) the extent to which team track operations can be efficiently substituted for warehouse operations on the larger terminals; (4) market operating expenses on various sizes and types of facilities; (5) types of market ownership; (6) the proper location of markets; and (7) other factors that effect the efficiency of market operations. It is contemplated that the results on this research would be published in a series of reports having the general title "How to Plan Market Facilities." The background data and material developed should enable the Department staff to do a more effective job of planning and promoting the construction of improved market facilities.

Publications

Wholesale Produce Markets--Management, Operating Expenses, and Income. J. S. Larson (in process). USDA. Marketing Research Report

MATERIALS-HANDLING RESEARCH IN THE STORES AND WAREHOUSES OF WHOLESALE PRODUCE DISTRIBUTORS - MRD

Progress and Findings - 1954 Committee Recommendation, "Initiate work to develop improved layouts and designs for the warehouses of service wholesalers of fruits and vegetables." (17/25)

Personnel were not available to initiate this work.

1954 Committee Recommendation, "Initiate research needed to improve work methods, equipment and facilities for handling, ripening, grading, sizing and packing tomatoes on terminal markets" (low c).

Resources were not available for starting this work.

Materials-handling operations in stores and warehouses are responsible for a significant part of the cost of marketing produce. The research reported here is being carried out to develop data and to determine for all kinds of packages of vegetables and fruits the most efficient types or combination of types of equipment for performing all materials-handling operations. In order to realize the full benefits from this research, it is necessary to use the results of materials-handling studies to develop the types of layouts and designs of facilities to obtain optimum environmental conditions in which the materials-handling operations should be performed.

During the past year, data obtained earlier was reviewed and analyzed. Results of this review revealed that additional time studies are needed to develop more reliable data for receiving, intrawarehouse handling, and loading out operations.

Data already developed indicate that produce dealers can make significant savings on materials-handling operations by shifting to some of the newer and more advanced types of materials-handling equipment.

Plans - This work will be continued with emphasis being placed on completing the field work on materials-handling operations during the current fiscal year. This will involve making time studies, as well as other industrial engineering studies, of the methods and equipment used for handling rigid and nonrigid containers in the stores and warehouses of wholesale vegetable and fruit dealers. A final report should be completed during the 1955 fiscal year.

- T. Proposals for Committee Consideration - Initiate research to develop improved layouts and designs for the warehouses of service wholesalers of vegetables and fruits. Improved layouts and designs for the warehouses of service wholesalers of vegetables and fruits should permit maximum efficiency of operations based on the types of materials handling and other equipment used, the amount of space required in work stations and for storage, the width of aisles, and the amount of space needed in relation to volumes handled. In developing improved designs, attention also would be given to structural requirements, refrigeration needs, and construction costs. About 5 warehouse layouts of different sizes and arrangements would be developed as an aid to wholesalers in planning new facilities or in remodeling existing structures. Numerous requests from service wholesalers for warehouse plans insure industry cooperation in the proposed project.

- U. Initiate research needed to improve work methods, equipment and facilities for handling, ripening, grading, sizing, and packing tomatoes on terminal markets. This research should determine the comparative efficiency of currently used work methods, devices, equipment, and facilities for handling, ripening, grading, sizing, and packing tomatoes on terminal markets and provide a basis for developing improved methods, equipment, and facilities for performing these operations. Studies to date on the use of electronic instruments for measurement of tomato color indicates the possibility of developing an electric tomato sorting machine. Such machinery would enable receivers of "green wrap" tomatoes to save labor and reduce losses by mechanically sorting green, green ripe, and pink tomatoes. During the past decade there has been a marked trend toward the ripening and packaging of tomatoes on terminal markets rather than at shipping points. This shift has led to numerous requests for assistance from terminal market handlers for assistance in determining the best methods, equipment, and facilities to meet their individual requirements. Industry interest is more than adequate to insure cooperation in such a study.

IMPROVED WORK METHODS, EQUIPMENT, AND FACILITIES FOR ASSEMBLING
FROZEN FOOD ORDERS - MRD

Progress and Findings - 1954 Committee recommendation, "Expand work on the development of improved work methods, equipment, and facilities for handling and storing frozen foods in wholesale distribution plants." (18/25)

During the past year, work on order assembly operations in wholesale frozen food distribution plants covered the development of a new power conveyor order assembly table. This table was designed, fabricated, and installed in a pilot plant and a handling system was designed around it, with a resultant 18 percent increase in order assembly productivity and a reduction in the cost of handling frozen foods. In addition, two types of handling systems were installed in other pilot plant locations, with the result of increases in productivity in these wholesale frozen food distribution plants.

In addition, recording and transcribing systems for receiving telephone orders by means of Ediphone equipment and the like, were installed in two pilot plants. The systems were improved during this past year to the point wherein the former systems are no longer used.

The increased productivity resulting from this engineering is approximately 80 percent in one of the plants, somewhat less in the other. Work was also accomplished in semiautomatic punchcard, and IBM order processing systems. Other work is being done on systems designed to meet the needs of the small- and middle-volume groups of distributors.

In addition to the equipment and work methods developed above, facilities of several pilot plants were completely redesigned, new bins and racks were installed, and modifications were made in the materials-handling methods which increased both the output per worker and the storage capacity of the plants concerned.

Plans - The handling of split cases, and the makeup of frozen food orders should be continued in order to develop optimum handling practices which will enable small-, medium- and large-volume frozen food distributors to increase the output per worker, and decrease the cost of handling.

Industrial handling equipment and other machines should be analyzed from the standpoint of adapting them to frozen food handling, either in toto, or by way of modifying the design.

New equipment should be developed which will enable distributors to increase worker productivity with less worker fatigue and less cost.

The work on automatic recording and transcribing of telephone orders should be continued and the results of this work should be expanded in order to obtain several alternate systems so that small- and medium-volume frozen food distributors may benefit as have the large-volume distributors in whose plants the initial work was implemented. The results of the past year's work in this area should be prepared for publication.

Work should be continued on improved order processing through the use of pegboards, semiautomatic (McBee), and automatic (IBM and similar) punchcard systems which will increase the effectiveness of inventory control, production control, and order assembly error controls.

Judging from the inquiries received by this Section, additional work should be done in the area of plant layout and design of facilities for frozen food distribution plants. This work entails relayout of old facilities, and the design of expanded facilities, together with the design and layout of new facilities.

Publication

The results of the above work have been described in the report, "Some Improved Methods for Assembling Orders in Wholesale Frozen Food Plants," which is now being prepared for publication by James A. Mixon and Theodore H. Allegri.

IMPROVEMENT OF DESIGN AND OPERATION OF PALLETIZED CONTAINER STORAGE
OF ONIONS - MRD

Progress and Findings - Mature brown globe onions, machine topped and harvested into one-ton capacity pallet boxes, were warehouse cured and stored 75 days with 4 percent weight loss. Onions thoroughly wet down immediately prior to storage were cured with unheated air from a continuously operating, low pressure fan, and thermostat controlled damper to regulate ventilation. This improved method of storage atmosphere control reduced the power requirement to one-half that of manually controlled ventilation and resulted in better temperature regulation.

Analysis of weaknesses observed in experimental pallet box design has resulted in improved design criteria.

Plans - Studies were suspended at Clear Lake, Iowa, during the 1954 season because of onion crop failure due to heavy rains. Further field investigation will be transferred to a commercial warehouse of 1,000-ton capacity located at Moorhead, Minnesota, where emphasis will be placed upon developing and improving methods and equipment for storing and handling onions in pallet boxes. Studies on developing improved methods and equipment for storing and handling onions and potatoes in pallet boxes at the Red River Valley Potato Research Center should be emphasized. A \$6,000 industrial forklift truck has been made available at no cost to the Government by one of the major refrigerator carlines. Efforts will be made to take full advantage of this equipment. A speech, in the nature of a progress report, was presented at the December 1953 meeting of the Iowa State Vegetable Growers Association.

IMPROVED LABOR UTILIZATION IN VEGETABLE PACKINGHOUSES - MRD

Progress and Findings - 1954 Committee Recommendation, "Initiate research needed to improve labor utilization in handling and packaging vegetables at shipping points" (low b).

Funds were not available for starting this work.

- V. Proposal for Committee Consideration - Expand research directed toward reducing packinghouse costs and initiate research to improve methods, facilities, and equipment for handling, cleaning, sorting, sizing, and packing vegetables at shipping and other assembly points. The University of Florida has requested that the AMS cooperate in carrying out such a study. Also, consideration should be given to the impact of improved technology such as vacuum and high velocity tunnel cooling, on handling and packing methods and costs.

IMPROVED HANDLING OF PRODUCE AND FROZEN FOODS IN RETAIL FOOD STORES - MRD

Progress and Findings - Industrial management and marketing techniques are being used to increase labor productivity and reduce costs through improved methods, equipment, materials, and layout of produce and frozen food departments in service and self-service type retail food stores. The research is conducted in cooperation with several retail organizations in different areas of the United States. Current methods of handling have been analyzed and improvements developed. Some of these improvements are currently being tested.

Plans - The research will continue for the remainder of the fiscal year. As improved methods are developed they will be tested in the stores.

Publications

"Frozen Food Handling Efficiencies at Retail" article released in Marketing Activities. USDA

"Some Comparative Methods of Packaging Potatoes and Onions at the Point of Distribution" Paul F. Shaffer and Dale L. Anderson. USDA mimeo.

- W. Proposals for Committee Consideration - Initiate work to develop an inexpensive portable conveyor specifically designed for unloading watermelons from railroad cars and motortrucks. Because of the rounded shape of the melons and their tendency to roll, none of the various types of conveyors now commercially available is suitable for this purpose. The melons are now handed into and out of trucks and cars at most points in "bucket brigade" fashion, which is wasteful of manpower, and frequently results in delays and some bruising of melons. If successful, consideration should also be given to the problem of loading melons into the car or truck at shipping point in order to reduce labor requirements, speed up the loading operation and reduce handling damage to the melons.
- X. Initiate a study of the potentialities of motortruck transportation of fresh fruits and vegetables from California and Arizona to midwestern and eastern markets. Because of the high level railroad rates and further increases threatened, west coast shippers have proposed that a study be made to determine the charges for the transportation of these commodities to midwestern and eastern cities, service factors, present level of traffic westbound for the return haul, and the limitations upon volume movement, particularly to the area east of the Mississippi River. Consideration will also be given to comparable railroad rates and services.
- Y. Initiate studies on transportation methods and costs on processed fruits and vegetables for cooperative and other canners from the North Pacific Coast States to Midwestern, North Central and Atlantic Seaboard Markets. This study would explore the possibility of reducing transportation and related costs of processed fruits and vegetables through analysis of alternative methods of transportation, rate structure, operating costs, and distribution practices. The study should include an analysis of private motortruck operating costs versus for-hire carrier charges, services to buyers, and physical and economic operating limitations on interstate truck movement. The practicability of developing cooperative or joint trucking associations would be explored.
- Z. Initiate an analysis of the extent (the relative and absolute amounts and the distances) which fresh fruits and vegetables now move by rail and by truck respectively. This would be based on data on unloads in major markets, on shipments out of Florida, Texas, and California. The study would be an up-to-date and more comprehensive sequel to a study of rail-to-truck diversion which the Department based on a comparison of 1948 and 1951. The information would be useful to the Department and shipper groups in rate litigation and would be of interest to carriers and shippers generally.

MARKET DEVELOPMENT

EFFECT OF RETAIL MERCHANDISING PRACTICES ON CONSUMER DEMAND FOR VEGETABLES - MRD

Progress and Findings - 1954 Recommendation, "Expand studies of effect of retail merchandising practices upon sales of fresh vegetables." (16/25)

Evaluation of the effect of various merchandising practices on the sales of, and consumer demand for, selected agricultural products has been expanded and is currently being carried out in a sample of stores in Pittsburgh, Pennsylvania. The merchandising experiments being conducted in Pittsburgh are a continuation of the same type of experimental research work done in cooperation with Pennsylvania State University and Cornell University in the spring of 1954. Two of the three merchandising experiments conducted last spring were devoted to lettuce and tomatoes.

The variables tested in the lettuce experiment included displaying lettuce for sale to consumers in both bulk and cellophane bags with variations in pricing based on a one or two-head price. The results of this experiment are being readied for publication.

The tomato merchandising experiment placed primary emphasis on packaging. Tomatoes were offered to consumers in bulk, regular cardboard tubes and a plastic tube which retailed at a three cent premium, but afforded the consumer the advantage of a full-view of the tomatoes. The preliminary results of the study indicated that consumers would pay the additional cost of selling full-view packages of tomatoes.

Products for which merchandising tests are now being conducted or are tentatively scheduled for this fiscal year include, among others, potatoes, fresh mushrooms and carrots. The variables designed to be tested with respect to potatoes and fresh mushrooms are being determined, primarily, by Pennsylvania State University. The carrot experiment is designed to determine the extent of consumer preference between bunch and prepackaged carrots. The packaged carrots will be sold in both one and two-pound cellophane bags to measure consumer acceptance of a larger package. The ultimate objective of this type of research is to promote wider use of successful marketing techniques as a means of promoting increased consumption of vegetables.

Plans - This work will be continued possibly including new commodities in substitution for commodities now being studied.

- AA. Proposal for Committee Consideration -- Expand studies to determine the effect of specified retail merchandising practices upon sales of agricultural products to additional areas and commodities. Substantial support and interest have been evidenced by the retail trade in testing and evaluating the use of specified practices -- packaging and package sizes, type, size and location of displays, pricing differentials and methods of pricing -- upon sales of and consumer demand for certain fresh vegetables as well as other commodities.

COLLECTION, ANALYSIS AND DISSEMINATION OF MARKET DATA

MARKETING OF BULK AND PACKAGED FRESH SPINACH AND TOMATOES - (Matching Funds) OES

Progress and Findings - The purpose of this study by the California station was to find out how consumers fare in buying perishable prepackaged products. It was found that bulk spinach and tomatoes were better in quality than the packaged goods. The edible packaged spinach and tomatoes cost 113 percent and 44 percent more respectively than in bulk. The convenience of packaged products did not outweigh with the majority of consumers their belief that the packaged products are not as good quality as the bulk. The lack of availability of bulk products in many stores indicated that some sellers were ignoring consumer preference for the bulk products.

Plans - Completed December 30, 1953

Publications

Pre-Packaged and Bulk Spinach. California Agriculture 7:13, 1953

Spinach at Retail, California Agriculture 7:14, 1953

Pre-Packaged, Bulk Tomatoes. California Agriculture 7:12, 1953

Fresh Tomatoes at Retail. California Agriculture 7:15, 1953

Why the Consumer Buys Pre-packaged or Bulk Spinach and Tomatoes.
American Vegetable Grower 1:15-25, 1953

Housewives Reaction to Pre-Packaged Spinach. Pre-Pack-Age October 1953

Pre-Packaged and Bulk Tomatoes. Pre-Pack-Age. 1954

A Study of Packaged and Bulk Spinach and Tomatoes: Quality, Price, Availability and Consumers' Reactions. Journal of Home Economics, 1954

METHODS OF SALE ON MARKETING CHARGES AND GROWERS RETURNS -
(Matching Funds) OES

Progress and Findings - This project was initiated by the Florida Station to investigate the conditions which determine the methods of sale used by Florida firms in marketing green beans, green peppers and tomatoes and the effect of methods of sale upon marketing charges and returns to growers. During the past year data on the number of handlers, location, principal products and volume of business was obtained. Data relative to packing charges for tomatoes, green beans and green peppers in various areas by types of containers has been obtained from 103, 79 and 72 growers, respectively.

Plans - During the coming year about four months of field work will be needed to obtain marketing charges and returns by types of firms and methods of sale from the organizations selected in the sample. Analysis of data will be made to determine: (1) advantages or disadvantages of specific methods of sale and conditions under which they should be employed; (2) pattern of prices received by methods of sale; (3) distribution of shipments during the season; (4) methods of shipment; and (4) reasons for employment of specific methods of sale.

THE MARKETING AND DISTRIBUTION OF MARYLAND CANNED VEGETABLES -
(Matching Funds) OES

Progress and Findings - A study was made by the Maryland Station of the sample canners sales of canned tomatoes, tomato juice, corn, snap beans and peas amounting to almost 11 million cases of these products for the period July 1949-June 1952. The leading States in order of total cases received were: Pennsylvania, New York, Maryland, Virginia, District of Columbia, New Jersey, Massachusetts. Wholesale buyers bought about two-thirds of all canned vegetables, chains purchased about one-sixth, Government agencies about one-tenth. Results of the freight rate analysis revealed that Tri-State canners have the advantage over Mid-West canners both by rail and truck into 17 Eastern States. Population of this area approximates 40 percent of the U.S. total. In order to increase sales in this area it would be of prime importance to strive for improved quality and most important a uniform quality under the same label from year to year. Many buyers were critical of Tri-State canned products and this is justified especially as referred to tomatoes.

Plans - Completed June 30, 1954.

Publications

Marketing of Tri-State Canned Vegetables, Part I - The Distribution Pattern, 1949 Pack, Maryland Agricultural Experiment Station Miscellaneous Publication No. 158. February 1953.

Marketing of Tri-State Canned Vegetables 1949-51 Pack. Maryland Agricultural Experiment Station Miscellaneous Publication

MARKETING FRUITS AND VEGETABLES THROUGH COMMERCIAL PROCESSORS -
(Matching Funds) OES

Progress and Findings - In an effort to improve the quality, uniformity and marketability of Georgia processed fruits and vegetables, qualitative data on the 1953 pack of 14 different kinds of fruit and vegetables were obtained from the 24 commercial canners operating in Georgia by the Georgia station in cooperation with the Agricultural Marketing Service. Work was initiated in January 1954 on the phase of the project pertaining to a study of the grade, quality, and retail price relationships for canned field peas (southern peas). Information as to grade, quality and retail price was obtained for various brands of canned field peas on the grocery shelf of 802 retail grocery stores. One can of each brand and variety were purchased and sent for grading.

Consumers were offered 56 different brands of field peas. Seven varieties of peas were among the various labels plus the all inclusive term "field peas."

Plans - Next year the canned field pea data will be analyzed. Studies will be initiated on some of the more important vegetables packed by Georgia canners.

B. Proposals for Committee Consideration

MARKETING RESEARCH

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A. Initiate studies for the development and improvement of marketing agencies in areas near consuming centers.	110
B. Reactivate the study of costs of processing deciduous fruits and vegetables.	119
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G. Initiate studies with cooperatives and other processors for selected fruits and vegetables to determine the optimum use of processing plant, feasibility of introducing new product lines, market potential for various forms of processed products, and off-season use of plant and personnel.	120
H. Expand research on fungicides for controlling post-harvest diseases of vegetables.	123
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M. Expand the study of sampling methods used in the inspection of fresh and processed fruits and vegetables to devise improved procedures where practicable.	148
N. Initiate a study to determine the effect of a quality grader on the yields of various grades of peas for canning.	149
O. Expand the work on the yield and quality of canned and frozen sweet corn in relation to raw product quality to another state such as Maine, New York, or Wisconsin after the various objective quality tests used in the Ohio project have been evaluated.	150

P. Accelerate expansion of research work on prepackaging fresh vegetables.	154
Q. Accelerate expansion of studies on the development and evaluation of improved and cheaper shipping containers for vegetables.	156
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S. Expand research to develop basic data for use in planning wholesale produce market facilities in specific localities.	161
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Z. Initiate an analysis of the extent (the relative and absolute amounts and the distances) which fresh fruits and vegetables now move by rail and by truck.	167
AA. Expand studies to determine the effect of specified retail merchandising practices upon sales of agricultural products to additional areas and commodities.	169

IV MARKETING SERVICE AND EDUCATIONAL WORK

A. Progress on Work Underway

SERVICE WORK OF USDA

VEGETABLE CROP ESTIMATES - AES

Progress and Findings -- 1954 Recommendation "Expand work on collection and dissemination of basic data and market, on production, distribution and prices of vegetables. (1/5) information

During 1954 the principal emphasis was on continuing the expanded program of vegetable estimates started in 1952. This program of monthly reports on acreage and production by States covers 29 of the principal vegetables (28 for fresh market and 11 for processing). The estimates for the fresh-market vegetables are also broken down by seasons, such as winter, spring, summer and fall. The present program covers 94 percent of the production of the 29 principal vegetables and 81 percent of the production of all vegetables grown for sale.

Although no additional funds were provided for further improvements in coverage, some progress was made on this problem in 1954. Preliminary investigations have been made for three new fresh-market vegetable deals: early fall tomatoes in western South Carolina, summer lettuce in Wisconsin, and summer sweet corn and cucumbers in north central Iowa. We anticipate that we will have to start estimates for these in the near future.

Considerable work has also been done on list sampling of vegetable growers in North Carolina. This project, which includes a complete enumeration of all of the larger growers in that State, will provide benchmark figures on the level of yields per acre and seasonal breakdown of acreage that will tie in with the 1954 U. S. Census figures on vegetable acreage.

Four special reports were issued covering: (1) the production of all commercial vegetables for fresh market and processing, 1939-53; (2) planted acreage of the principal commercial vegetables for fresh market, 1952 and 1953; (3) planted acreage of principal crops for commercial processing, 1951, 1952 and 1953; and, (4) usual planting and harvesting dates and principal producing areas for commercial vegetables for fresh market.

Item (1) covers only national production on an annual basis and is used principally as a basis for calculating per capita consumption figures.

Items (2) and (3) are used primarily in setting the Department's vegetable acreage guides, but are available to others upon request.

Item (4) is a revision of a previous publication on this subject. This bulletin has been revised to include all crops and States covered in the expanded program of monthly vegetable reports. This publication is used extensively by farm labor agencies in their recruitment programs for farm labor.

Work was virtually completed on a companion bulletin giving usual planting and harvesting dates and principal producing counties by States for vegetables for commercial processing. This bulletin, the first of its kind for processing vegetables, will be published in the spring of 1955. In addition to general uses, such as for farm labor recruitment programs, it will also provide information needed when the work of estimating these crops is transferred from the Washington office to the State offices concerned. At the present time only ten State offices participate in the preparation of the estimates for processing vegetables. Facilities are not available for transferring the work from Washington to the thirty other State offices concerned.

Work was also started on a canning-freezing breakdown of the national estimates of sweet corn for processing. Present plans are to start publication of this canning-freezing breakdown with the 1953 and 1954 crops in the December 1954 Annual Summary report.

Plans - If funds are available, the present expanded program of monthly vegetable reports will be continued in 1955-56.

Proposals for Committee Consideration -

- A. Further improve the expanded program of monthly commercial vegetable estimates by: (1) Making more extensive surveys and field investigations, particularly in local market areas, (2) transferring the work on processing vegetable estimates from the Washington office to the other 30 State offices concerned, so this work can be coordinated with that on fresh-market vegetables now handled by these State offices, (3) expanding the coverage to include additional crops, particularly pumpkin and squash for processing and squash for fresh market.

- B. Initiate January 1 estimates of stocks of sweetpotatoes in commercial storages in the ten States that have virtually all of the holdings on that date. We have had numerous requests for this information in recent years, but facilities have not been available to do this work.

Publications

In addition to the regular monthly reports on fresh market and processing vegetables, the following special reports were issued:

Production of All Commercial Vegetables for the Fresh Market and Processing, 1939-1953, TC-53: 1249

Commercial Vegetables for Fresh Market, Planted Acreage of Principal Crops, 1952 and 1953, TC-53: 1251

Vegetables for Commercial Processing, Planted Acreage of Principal Crops, 1951, 1952 and 1953, TC-53: 1252

Commercial Vegetables, Usual Planting Dates, Usual Harvesting Dates, Principal Producing Areas, by Seasonal Groups and States, November 1954.

MARKET NEWS REPORTING OF TRUCK SHIPMENTS AND TRUCK RECEIPTS -FV

Progress and Findings - 1954 Recommendations, "Expand collection and dissemination of basic data and market information on production, distribution, and prices of vegetables." (1/5)

Work to extend motor truck reporting has been under way for several years but limited funds have permitted only a very minor expansion. Truck shipments of fresh fruits and vegetables now are being reported on a daily basis in Arizona, California, Florida, the lower Rio Grande Valley of Texas, and seasonally in a few other localized shipping areas. During the past year, weekly reports were inaugurated on truck shipments of Oregon and Washington apples and pears and Oregon potatoes. Truck arrival reports were started during the past year in Cincinnati, bringing to 19 the number of major terminal markets in which truck receipts are reported.

Plans - Reporting of truck receipts and truck shipments on an origination point basis will be extended to additional markets and major shipping areas as rapidly as funds will permit.

- C. Proposal for Committee Consideration - Expand market news reports to include more information on truck receipts and truck shipments. It is proposed that the reporting of truck receipts by commodities and States of origin be extended to a total of 75 major terminal markets as rapidly as possible, and that the reporting of truck shipments be extended to additional major vegetable shipping areas where practicable. While such extended reporting will not give as complete a picture of truck movement of fresh fruits and vegetables as is now available on rail shipments and rail unloads, it is believed that it will provide sufficient coverage to indicate accurately the day-to-day and week-to-week trends in the total volume moving by truck.

WHOLESALE-RETAILER TRAINING UNDER CONTRACT IN MERCHANDISING OF
FRESH FRUITS AND VEGETABLES - FV

Progress and Findings - 1954 Recommendations, "Expand wholesaler-retailer training in the merchandising of fruits and vegetables."
(2/5)

During the past year the program of wholesaler-retailer training in merchandising of fresh fruits and vegetables, conducted under contract by the United Fresh Fruit and Vegetable Association, has been made available to areas of the country not previously reached. In addition, increasing emphasis has been given to the establishment of merchandising departments for wholesalers and the training of merchandising managers and assistants to staff these departments.

Since the inauguration of this program, approximately 35,000 retailers and their employees have received instruction in training classes conducted in 42 States, the District of Columbia, and the Territory of Hawaii. Of these, over 4,000 were trained in the 12-month period ended September 30, 1954. In addition to the retailers trained, a total of 59 merchandising departments have been established for wholesalers with 59 merchandising managers and 513 assistants trained. During the 12 months ended September 30, 1954, a greater volume of this type of work was conducted than during any earlier 12-month period.

Plans - The present contract with the United Fresh Fruit and Vegetable Association expires in October 1955. In keeping with the Committee's 1954 recommendation, it is planned to continue the merchandising training program under contract beyond this date with as much increased emphasis upon the training of wholesalers' merchandising managers and assistants as possible without detracting from the instruction for retailers since it is the foundation upon which the remainder of the program is built.

PLANNING MARKETING FACILITIES IN SPECIFIC LOCALITIES - MRD

Progress and Findings - 1954 Committee Recommendation, "Improvement of Market Facilities." (5/5)

During the past year, 34 localities were assisted in planning and constructing improved marketing facilities. In addition, information was furnished a large number of individuals who were interested in building wholesale stores, warehouses and other kinds of individual facilities for the handling of farm and food products.

Wholesale produce markets for which studies were made by USDA were completed or were in various stages of construction in 9 places: Boston; Savannah; Jacksonville, Texas; Houston; Indianapolis; Louisville, Nashville, Rochester; and San Juan. In 5 of these the new markets are operating.

During the year 10 reports were published or were in manuscript form almost ready for publication. These included publications setting forth the results of studies to develop plans for wholesale produce markets in Birmingham and San Diego; supplements to previous reports on wholesale markets in Baton Rouge and Waco; and a very extensive report on the management, operating expenses, and income of 45 wholesale markets throughout the United States. The last mentioned report will be of great assistance to those planning new wholesale markets in determining what their expenses of operation will be and also will assist managers of existing markets in determining whether or not their costs of operation are in line with those of other markets.

A number of new studies were started during the year. The largest of these was a study in Philadelphia to develop plans for a complete wholesale food center to serve the city and surrounding trade territory. This center will occupy some 420 acres. The plan includes facilities for wholesalers of fruits, vegetables, meats, poultry, eggs, butter, cheese, fish, frozen foods, dry groceries, and allied industries. In several localities in which market facility studies were made in previous years follow-up work has been necessary in giving assistance in the choosing of sites, the development of layouts, determining possible methods of financing, and planning for market management and operation. In several cases, upon request, State and local groups have been given assistance in preparing legislation dealing with market facilities.

Throughout the year the Branch continued to receive many more requests for assistance in planning market facilities than it could meet. While an effort has been made to confine the work to those places where the need is greatest and where the interest indicated that action would be taken, still it is impossible to comply with all the worthwhile requests that were received.

Plans - This work will be continued. As studies are completed in one locality, personnel and resources will be shifted to other localities where specific requests have been made for assistance.

Publications -

The Wholesale Produce Market at Birmingham, Ala., S. D. Clark, January 1954; Wholesale Produce Markets of San Diego, Calif., T. D. Johnson, May 1954; Wholesale Produce Markets--Management, Operating Expenses, and Income, J. S. Larson - (being processed).

DEVELOPMENT OF NEW AND REVISED STANDARDS FOR GRADES OF PROCESSED
VEGETABLES AND THEIR PRODUCTS - FV

Progress and Findings - 1954 Recommendations, "Expand the work on the revision of current standards for processed vegetables and the development of new standards for products not yet covered." (6/25 Res.)

During the past year the grade standards for tomato catsup, pickles, frozen green and wax beans and mixed vegetables were revised. New standards for chili sauce, tomato sauce and frozen cooked squash were developed and issued. Proposals for discussion and comment were published for revision of the grade standards for canned peas, beets and carrots. In addition, data have been developed for revising the standards for canned asparagus and pimentos. Data have also been obtained for use in development of new grade standards for frozen peas and carrots.

In order to provide more uniform interpretation of the quality requirements in the standards, the development of visual aids such as photographs, drawings, models, and other devices for illustrating objectively certain quality characteristics has been emphasized during the year. A set of 17 wax models of blemishes on green and

wax beans has been made. A set of models showing range of color in wax beans has been perfected. Models of color found in canned peas have been duplicated. Three sets of broccoli pictures showing stages of development have been painted in natural colors. Models of asparagus spears showing color and head development have been prepared.

Methods for determining the drained weight of frozen vegetables are being tested along with standard cooking procedure for use in the inspection of the product.

Plans - It is planned to complete new standards for frozen peas and carrots and revisions for canned peas, beets, carrots, asparagus and pimentos. Revisions of the standards for frozen asparagus, frozen peas, canned pumpkin, and frozen spinach will follow these. If time is available, revisions will be started on canned and bulk sauerkraut and new standards for dehydro-frozen pimentos and frozen peppers.

It is planned to complete the production of wax models for cucumber pickle blemishes, and wax bean models showing classes of blemishes. These will then be distributed to all inspection offices. Color comparators for lima beans, canned pimentos, and canned tomatoes are planned.

It also is planned to test further methods for counting specks in tomato products and methods for determining the drained weight of frozen vegetables.

- D. Proposal for Committee Consideration - Expand work on development and revision of U. S. Standards for grades of processed vegetables and vegetable products, including more extensive testing and evaluation of objective methods for measuring quality characteristics. The most urgent need now appears to be grade standards for new frozen products such as frozen peppers, melon balls, and dehydro-frozen vegetables. There is a need for an increased amount of work on testing and evaluating objective methods for determining quality such as the shear press, consistometers and various moisture testers to determine their suitability for incorporation in grade standards and official inspection procedures. In addition, acceptable quality cut-off points, in line with good commercial practices must be determined in connection with the use of each of these objective methods.

Publication

New or revised standards are published in the Federal Register when promulgated and duplicate copies are available to interested parties.

DEVELOPMENT AND REVISION OF CONSUMER STANDARDS FOR FRESH VEGETABLES - FV

Progress and Findings - 1954 Recommendations, "Expand work on the revision of current consumer standards for packaged vegetables and the development of new consumer standards for products not yet covered." (7/25 Res.)

At the request of industry representatives new consumer standards for parsnips and turnips were developed and issued during the past year. In addition the consumer standards for carrots were revised to incorporate changes comparable to those made recently in a revision of the wholesale standards for carrots.

Plans - This work will be continued in response to requests from industry representatives.

Publications -

New or revised standards are published in the Federal Register when promulgated and duplicate copies are available to interested parties.

MARKET SITUATION AND OUTLOOK - AEG

Progress and Findings - An analysis of civilian per capita consumption of commercially grown vegetables other than melons (total, fresh and processed, fresh equivalent basis) from 1937 to 1953 has been published in The Vegetable Situation (TVS - 113) dated July 28, 1954. The study indicates that consumption has been on the uptrend since 1937, and by 1953 was more than one-fifth higher than the prewar (1937-39) average annual rate. Most of the expansion occurred for the processed vegetables, reflecting in part the effects of the shift in population from farms to urban areas plus the accompanying decline in production of food at home, the general availability of processed vegetables throughout the year, more stability in prices and more uniformity of quality of the commercially prepared products, and convenience in this use.

Civilians still consume the largest part of the commercially grown vegetables in the fresh form. However, because of the rapid expansion in the per capita consumption rate of the processed products--particularly the frozen ones, the proportion consumed as fresh vegetables has been declining slowly since 1937. Nevertheless, more than half of the total continues to be purchased in the fresh form by consumers. The increase in the per capita consumption of frozen vegetables since before the war has been very large, but is still only a relatively small part of the total vegetables (fresh and processed combined, fresh equivalent basis) consumed in this country.

For a number of the important vegetables which are purchased in the fresh and processed forms by civilians, the study includes for each of the items a brief analysis of the shifts in the ~~consumption~~ rate as among the fresh, canned or frozen forms.

The study of factors affecting prices and production of selected vegetable crops, mentioned in the previous report to the committee, is currently being printed and will be issued as Agriculture Technical Bulletin 1105 in the near future. This study highlights the characteristics of production, marketing, and price making for such major crops as lettuce, cabbage, tomatoes, green peas, and onions.

Plans - The series of periodic marketing reviews and forecasts will be continued on established schedule.

- E. Proposal for Committee Consideration - Expand the vegetable outlook work with special attention to regional differences.

Publications -

The Vegetable Situation, quarterly

The Demand and Price Situation, monthly.

The National Food Situation, quarterly

"The Demand and Price Structure for Selected Vegetables"
Dallas M. Shuffett, U.S.D.A. Tech. Bul. No. 1105

B. Proposals for Committee Consideration

- A. Further improve the expanded program of monthly commercial vegetable estimates by: (1) Making more extensive surveys and field investigations, particularly in local market areas, (2) transferring the work on processing vegetable estimates from the Washington office to the other 30 State offices concerned, so this work can be coordinated with that on fresh-market vegetables now handled by these State offices, (3) expanding the coverage to include additional crops, particularly pumpkin and squash for processing and squash for fresh market.
- B. Initiate January 1 estimates of stocks of sweetpotatoes in commercial storages in the ten States that have virtually all of the holdings on that date.
- C. Expand market news reports to include more information on truck receipts and truck shipments.
- D. Expand work on development and revision of U. S. Standards for grades of processed vegetables and vegetable products, including more extensive testing and evaluation of objective methods for measuring quality characteristics.
- E. Expand the vegetable outlook work with special attention to regional differences.

SERVICE WORK OF STATE DEPARTMENTS OF AGRICULTURE

A. Progress on Work Under Way

During the past year 19 State Departments of Agriculture carried on marketing service activities pertaining to vegetables. The work centered around (1) quality improvement and maintenance, (2) expanding market outlets, (3) the collection and dissemination of local and nearby market information and (4) technical assistance in improving existing market facilities and designing and locating new facilities.

IMPROVING AND MAINTAINING PRODUCT QUALITY THROUGH BETTER GRADING,
HANDLING AND PACKING

Progress and Findings - 1954 Recommendations, "Expand work in improving grading, packing, handling and shipping methods with producers and all marketing agencies." (4/5) "Expand work in wholesaler-retailer training in the merchandising of fruits and vegetables." (2/5) Additional funds permitted some expansion.

During 1953-54 packing, grading and handling assistance and demonstrations were provided in Alaska, California, Hawaii, Kansas, Kentucky, Michigan, Mississippi, South Carolina and West Virginia. In Alaska bulk and packaged carrots were displayed side by side in a warm room to demonstrate the extent to which the keeping quality of carrots is improved by prepackaging. Twenty-two grading and packing demonstrations, with an aggregate attendance of about 250 persons, were held in Hawaii covering tomatoes, pineapples, cucumbers, peppers, snap beans and other products. In addition, assistance in improving handling methods was provided to 3 packing sheds, 11 growers and 1 wholesaler. Handling demonstrations held in Mississippi through the joint sponsorship of the State Department of Agriculture, the Farmers' Central Market Board and the Extension Service were attended by more than 3000 persons. Interest among producers in familiarizing themselves with proper grading and packing techniques was particularly high in areas recently new to vegetable production. Growers in a new watermelon area received such favorable prices, partly as a result of the quality program, that they plan to double acreage next year. Good results were also obtained for tomatoes, sweet corn, spinach, okra, squash, lima beans, sweetpotatoes and mustard and turnips greens. It is estimated that Mississippi producers realized an average price premium of about 10 percent for all vegetable crops because of the quality program. In Kentucky, at the request of the Extension Service and market managers, demonstrations and assistance were provided 250 producers in packing, grading and handling pink tomatoes for market -- a new enterprise in a number of areas. Later, at the request of processors, producers were advised with respect to the proper stage of maturity to pick tomatoes for canning. Publications were issued to growers summarizing the points to remember while picking, packing and grading. A similar publication was issued to growers marketing snap beans for the fresh market. In Michigan, growers are now required to observe U.S. grades and State labeling regulations for tomatoes, cantaloupes and slicing cucumbers. The use of these grades and regulations were explained and demonstrated about the State in cooperation with the Extension Service. Eight sweet potato digging and field grading and handling

demonstrations, attended by 300 growers, were provided in South Carolina in cooperation with the Experiment Station. The Experiment Station has developed a digging plow which eliminates the need for a second plowing and a separate vine cutting operation. Better grading and marketing of South Carolina tomatoes, cantaloupes and sweet corn were promoted through demonstrations and newspaper publicity.

The Kansas quality program was concerned primarily with informing producers and packers of the need for giving more attention to proper grading procedures. Demonstrations were provided upon request to producers, packers and wholesalers. This year as a result of better grading and quality maintenance, a premium of 1 to 1½ cents per pound or an additional income of more than \$1,000,000 was received from the sale of cantaloupes. Illinois growers are being encouraged to market their canning corn, peas and asparagus on the basis of grades, since the use of grades in nearby States has resulted in substantially increased returns to producers. As a result some canning asparagus was purchased on a graded basis for the first time this past year. Cooperation in this work was provided largely by the Federal-State Inspection Service, though contacts with the Extension Service indicate that these groups stand ready to help wherever possible.

Technical assistance in improving and maintaining quality and improving operating efficiency was provided local canners in Virginia and Tennessee. In three years of such assistance in Virginia, the proportion of the tomato pack grading sub standard was reduced from 30 to 10 percent. In addition, 33 continuous cookers, 12 exhaust boxes and 30 stainless steel inspection tables have been installed in canneries, and 5 plants have completely screened and 10 improved waste disposal methods. The Indiana sanitarian maintained supervisory control over the sanitation and quality control technicians in the 12 plants cooperating in the program. Warehouse certificates (indicating mold count, U.S.D.A. grades, etc.) were issued on about 900,000 cases of canned tomatoes, tomato puree, tomato juice, tomato catsup and canned corn.

Work on grading and handling included assistance in developing better methods as well as assistance and demonstrations in applying existing approved techniques. In Alaska, data was assembled and disseminated to producers and wholesalers on types of bags and packing and closure equipment best suited to carrot pre-packaging. Work was conducted in California in the development of more dependable methods of determining maturity of Persian melons and watermelons. Such methods will be used

by industry in picking operations and by enforcement agencies in standards work. For honeydew melons, comparative tests were made of the soluble solids content of the juice in the edible portion of the melon using the Balling or Brix scale hydrometers, presently the customary methods, and the faster sugar scale hand hydrator. The California Agricultural Code states that cantaloupes shall not be poorly netted. In California poor netting is generally associated by most growers and shippers with low soluble solids content and poor eating and carrying qualities. Tests to ascertain whether such a relationship exists indicate that there is no consistent relation of flavor to netting, that melons with good netting have a high soluble solids content, and that all poorly netted melons do not have a low soluble solids content. In Hawaii, comparisons were made of the length of time tomatoes picked at various stages of maturity would retain their quality when held at room temperature and when refrigerated. And a survey of retail stores there indicated that 50 percent of the stores in middle income areas would like to see consumer grades established for consumer sized packages of vegetables, but that only 29 percent of the stores in low income areas favor the use of such grades. Maryland producers and retail chain stores in Washington and Baltimore were assisted in developing a joint quality maintenance program for fresh sweet corn. The program involved using staggered plantings to assure a steady supply throughout the season; various devices for cooling upon picking, in one instance a hydrocooler; transportation at low temperature, and; the use of ice in the retail store for corn on the produce rack and of refrigeration for holding additional supplies. One grower shipped his corn to market iced in 5-dozen-ear wet strength paper bags. This program resulted in a substantial increase in corn sales in the cooperating stores, and a net profit to producers, after considering increased costs, of 2 cents per dozen over the profits realized for corn handled in the usual manner.

The lack of uniformity of the types of packages used for New York vegetables and their lack of effectiveness in maintaining quality in transit are believed by the State Department of Agriculture to be the major deterrents to market expansion for these products. As a result shipping and handling tests were made of various types of present and proposed new packages and the opinions of producers, shippers, wholesalers and others were sought regarding the shortcomings of packages now being used and the types of packages that would be more desirable from the points of cost, economy of space used in transit and storage, protection of vegetables from loss and spoilage and attractiveness of appearance.

- A. Proposal for Committee Consideration - Expand programs to improve and maintain the quality of vegetables through the development and adoption of better harvesting, grading, packing and other handling methods.

EXPANDING MARKET OUTLETS

During 1953-54 assistance was provided in improving and widening the distribution of vegetables in North Carolina, Maryland, Kentucky, Indiana, Illinois, Alaska and Hawaii. The "Indiana Produce Supply Report" was continued covering location, anticipated supplies and harvest dates of locally produced vegetables, principally carrots, cabbage, green beans, parsnips, turnips, onions, cucumbers, hot house lettuce, tomatoes, cantaloupes and watermelons. This report was mailed weekly to about 700 persons and firms including shippers, brokers, truckers and other potential buyers. The purpose of the program is to expedite the movement of the commodities into trade channels with minimum loss and spoilage and at maximum return to producers. The North Carolina, Illinois and Kentucky Departments of Agriculture issued similar reports. In recent years the production of tomatoes, snap beans and other vegetables in Kentucky has expanded rapidly. For the benefit of buyers in and outside the State, a report entitled the "Kentucky Vegetable Report", containing data about new areas, production estimates, varieties, market facilities, harvest dates, and the names and addresses of marketing agencies and county Agricultural Extension Agents, was issued just prior to the harvest season. Current information was also provided during the season on volume of marketings by area.

Promotional assistance in developing wider distribution of vegetables was provided in Maryland and Indiana. In Indiana a weekly report promoting vegetables in plentiful supply was released to consumers through 35 newspapers and 97 radio stations. In this connection 13 special television programs were devoted to informing consumers how to get the maximum from their food dollars in terms of both quantity and quality. In Maryland, a weekly radio program included a summary of commodities in plentiful supply. And a special newspaper campaign was carried on to promote the sale of cantaloupes.

The Alaskan carrot crop produced during the 1953 season was $2\frac{1}{2}$ times larger than normal. To help dispose of the surplus, producers were assisted in obtaining military contracts for the purchase of their carrots extending through May of 1954 - three months longer than the period provided in earlier contracts. The Department further assisted producers in obtaining permanent expansion of their carrot market through the development of methods and facilities for pre-packaging. This year, with growers prepared to pre-package, consumer demand has increased substantially and military contracts specify pre-packaged rather than bulk bunched carrots. In Hawaii, several surveys were made to bring together data helpful in market expansion activities. Controlled retail store experiments indicated that consumers would pay a substantial premium for and use larger quantities of high quality snap beans and that they prefer tomatoes showing $\frac{3}{4}$ red to full red (not full deep red) color.

- B. Proposal for Committee Consideration - Expand programs for widening market outlets and moving seasonal surpluses by providing buyers and other marketing agents with complete information on available supplies and by providing promotional and other assistance.

COLLECTION AND DISSEMINATION OF BASIC DATA AND LOCAL AND NEARBY MARKET INFORMATION

Progress and Findings - 1954 Recommendation, "Expand service work in the collection and dissemination of basic data and market information on production, distribution and prices of vegetables." (1/5)

Additional funds permitted some expansion in this field during 1954-55.

During 1953-54 producers and processors need data on basic consumption trends in order to develop effective long term marketing programs. Important types of information required are trends in acreage and production, changes in consumer demand, the competitive price situation in markets, quantities in storage and the rate of disappearance, and cost data for packaging, grading, handling and storing. Basic data of this general type were collected, analyzed and reported to producers, dealers and other interested groups in Kansas, Maryland, Michigan, Massachusetts, New York, Puerto Rico and Virginia.

A publication entitled "Maryland Agricultural Statistics" includes data on a State basis on the harvested acreage, yield per acre, and production and price of vegetables for fresh market and for processing covering the period 1919 to 1952. The Kansas and West Virginia Departments of Agriculture largely completed the preparation of historical summaries of prices received by farmers extending back to the early 1900's. In Michigan data were reported on trends in celery production in competing States and marketings from those States in major Michigan celery markets. Shortly prior to the 1954 season, the Massachusetts Department of Agriculture released information summarizing for all vegetables, (1) intentions to plant in 1954 compared with 1952 and 1953 intentions, (2) harvested acreage by counties during 1952 and 1953, and (3) total production and average yields and prices during 1952 and 1953. In Wisconsin data were assembled on methods of marketing canning peas and corn and on the acreage and production of these commodities on a county basis.

The New York Department of Agriculture continued testing the feasibility of using objective sampling methods to forecast more accurately the production of onions. Using this method, dependable estimates were made this past year for one major producing area. In Puerto Rico the experimental crop estimating program was completed this past year and is now going forward as a part of the regular insular marketing service program.

In Virginia, information was assembled on the proportion of Virginia canned tomatoes moving through the various channels of trade and to the principal consuming centers. And a survey was made of the number of sweetpotato storages located in Virginia, their capacity and location, and the methods of storing and marketing sweetpotatoes. The report on the survey concludes that grading and handling methods need improving, and that too large a portion of the crop is sold uncured at harvest time resulting in abnormally low prices, due to inadequate and inefficient use of available storage.

Market information releases were issued periodically in Alaska and Michigan. These releases included up-to-date summaries of prices, marketings, quantity and location of available supplies. In addition, the Michigan onion releases included reports on conditions in Texas so that Michigan producers and dealers might schedule their marketings to avoid a gap or overlap between the marketing season of storage onions and that of the new crop from southern Texas.

- C. Proposal for Committee Consideration - Expand programs to collect and disseminate basic data and local and nearby market information.

Publications

"Growers' Guide for Marketing Tomatoes for Fresh Market"; Kentucky Department of Agriculture.

"Growers' Guide for Marketing Canning Tomatoes"; Kentucky Department of Agriculture.

"Growers' Guide for Marketing Snap Beans"; Kentucky Department of Agriculture.

"Kentucky Vegetable Report" (This publication is issued to buyers. It contains data on acreage, estimated dates of harvest, available marketing facilities and sales agencies); Kentucky Department of Agriculture, June 21, 1954.

"North Carolina Fruits and Vegetables, Schedule of Movements, 1954"; North Carolina Department of Agriculture, March 1, 1954.

"Maryland Agricultural Statistics"; Bulletin X-7, Maryland Department of Markets.

"Special Celery Release" (trends in celery production in Michigan and competing States); Michigan Department of Agriculture, February 8, 1954.

"Massachusetts Vegetable Crops" (contains data on 1954 planting intentions, 1953 harvested acreage by counties, and yields and prices); Massachusetts Department of Agriculture, May 1, 1954.

"Growing and Selling Sweet Potatoes in Virginia"; Virginia Department of Agriculture, Extension Service and Truck Experiment Station.

IMPROVING MARKET FACILITIES AND EQUIPMENT AND REDUCING COSTS

Progress and Findings - 1954 Recommendations, "Expand service work in improvement of market facilities." (5/5)

Additional funds permitted some expansion in this field during 1954-55.

During 1953-54 Technical assistance was provided in improving existing marketing and processing facilities and equipment, and in designing and locating new facilities in West Virginia, Virginia, Tennessee, South Carolina, North Carolina, Mississippi, Maryland, Kentucky, Indiana and Kansas. In South Carolina producer and wholesaler groups were assisted in appraising their facility needs and in developing new facilities where required. For instance, a study of watermelon marketing in Allendale county revealed the need for a concentration point for truck buyers and a covered shed facility was established through the efforts of the Marketing Commission and local people. In contrast, another group was discouraged in its plans to construct a redistribution center for vegetables. Data presented by Department specialists indicated that the area was well served by local assembly markets and that a new center would encounter very strong competition from existing large redistribution centers. In Virginia, a market site study requested by the Fredericksburg City Council recommended the construction of a new wholesale and farmers' market with 3 wholesale store units and 25 farmer sheds. Assistance was also provided the Richmond Market Authority and the Norfolk Port Authority in planning new markets in general accordance with recommendations of studies made by the U. S. Department of Agriculture. Growers in a new Kentucky pink tomato producing area were assisted in organizing a central packing and selling cooperative and in constructing and operating the required facilities. Similar assistance was provided southern Illinois cucumber and pepper producers, though vegetable production was not new to the area. Cucumbers packed in the central packing house brought about \$1.00 and peppers \$.65 per bushel more than those packed on the farm in the usual manner. Technical assistance in the planning, location, construction and operation of processing plants was provided in Tennessee. Growers are being encouraged to help in establishing local plants by assuring processors of enough volume to permit efficient operations.

Fuller utilization was made of the Farmers' Central Market in Jackson, Mississippi through a special program to acquaint producers with the facilities available in the market sponsored by the State Department of Agriculture, the Extension Service and the Farmers' Market Central Board. More than twice as much produce moved through the market than in any previous years.

- D. Proposal for Committee Consideration - Expand service work in improving existing facilities and designing and locating new facilities such as country assembly markets and processing plants, and advising marketing agencies with respect to the kinds of handling equipment and methods best suited to their operations.

Publications

"Watermelon Marketing in Allendale County, South Carolina"; SMC12, A Special Report for the State Marketing Commission by B. J. Todd and J. E. Pittman, January, 1954.

"Sweetpotato and Truck Crop Marketing in Horry County, South Carolina"; SMC 11, A Special Report for the State Marketing Commission by B. J. Todd and C. D. Evans, July, 1954.

"A Brief Analysis of Production and Market Facilities for Commercial Vegetables in South Carolina"; Circular 91, South Carolina Experiment Station, July, 1953.

"A Survey of the Truck Crop Marketing Situation in the Pee Dee Area of South Carolina"; SMC 13, A Special Report for the State Marketing Commission by C. D. Evans and B. J. Todd, June, 1954.

B. Proposals for Committee Consideration

Expand service work carried out by State Departments of Agriculture. Such expansion should include emphasis on

- A. Programs to improve and maintain the quality of vegetables through the development and adoption of better harvesting, grading, packing and other handling methods.
- B. Programs for widening market outlets and moving seasonal surpluses by providing buyers and other marketing agents with complete information on available supplies and by providing promotional and other assistance.
- C. Programs to collect and disseminate basic data and local and nearby market information.
- D. Service work in improving existing facilities and designing and locating new facilities such as country assembly markets and processing plants, and advising marketing agencies with respect to the kinds of handling equipment and methods best suited to their operations.

EDUCATIONAL WORK OF COOPERATIVE EXTENSION SERVICES

A. Progress on Work Under Way

Educational work on the marketing of vegetables is conducted by the Cooperative Extension Services, usually as general programs involving fruits, vegetables and potatoes in most of the important producing States.

Consumer information projects aimed at encouraging consumption of products in heavy supply are in operation in most of the heavily populated States. Educational programs with retailers, having as their objective reduction of waste and better merchandising of foods, are being conducted in about two-fifths of the States. Commodity marketing projects were in operation in practically all important States where fruits and vegetables and tree nuts were grown in 1953-54.

These educational programs are conducted by State extension marketing personnel. Many of them were on regular extension funds long before the passage of the Research and Marketing Act of 1946. In addition to these regular fund marketing programs, county agricultural agents work on many local problems which do not involve college staff personnel.

For the sake of simplicity, vegetable marketing work has been broken into the following general areas:

EDUCATIONAL WORK AT COUNTRY POINT WITH FARMERS AND MARKETING AGENCIES ON IMPROVED MARKETING PRACTICES, METHODS, AND ORGANIZATION

Progress and Findings - 1954 recommendation "Expand present educational activities in analyzing and disseminating market information on production, distribution, and prices of vegetables." (1/5)

In cooperation with AMS, a vegetable acreage and marketing guides program was initiated, with special emphasis in Texas, Mississippi, Georgia, North Carolina, South Carolina, and California. The States of California, Oregon, Washington, Texas, Florida, Maryland, Michigan, and Pennsylvania have increased their staff doing this type of work with vegetables.

Practically all extension marketing specialists devote some time to outlook for various vegetables, including an analysis of the competitive position of specific vegetables in the market place, trends in consumption, and the supply available from various producing areas. An example of this type of work includes North Carolina and Mississippi where a number of buyers in northern consuming centers are supplied, at their request, with information about expected supplies and shipping dates for certain vegetables. In cooperation with AMS, a vegetable acreage and marketing guides program with producers was carried out in connection with existing outlook work in Texas, Mississippi, Georgia, Virginia, North Carolina, South Carolina, and California.

1954 recommendation, "Expand educational programs to improve grading, packaging, handling, and shipping methods with producers and all marketing agencies." (4/5)

New AMA projects were initiated in Kentucky, Louisiana, and Oregon and additional projects in Maryland and Florida.

During the past year there were some 18 AMA projects dealing with vegetables in 16 States. Generally, there are one to two full-time specialists employed on each of these projects. Educational programs with growers and others at country point involve at least two types of work: (1) The solution of specific marketing problems, and (2) general economic outlook and informational work. Work on specific problems involves such activities as the development of marketing organizations, analysis of marketing structure for vegetables and educational programs on the grading, packaging, grower-processor relationships, market outlets, etc. Agricultural outlook work on market prospects for various vegetables is also an important phase of extension marketing programs with this group of people.

Since 1948 considerable research and experimentation have been carried out to improve the quality of fresh sweet corn on the consumers' table. A number of land-grant colleges and the Department have been involved in this program, as well as commercial firms and marketers. The quality in sweet corn appears to be dependent on sweetness, flavor, tenderness, and succulence. Tenderness and succulence are used to determine the proper picking maturity, at which time the sugars content is near maximum. Immediately after harvest, there is a rapid loss in these four quality factors, particularly sugar, unless the sweet corn is quickly cooled below 40° Fahrenheit.

During 1953 Georgia conducted demonstrations on improved methods in harvesting, handling, and selling sweet corn. Two methods of packaging were tried--a multi-wall wet strength paper bag and a wire bound crate, with both containers holding five dozen ears. Crushed ice was used with both types of containers. The corn was harvested in early morning while it was cool and was on its way to Atlanta by mid-afternoon where it was delivered to modern warehouses with adequate refrigeration. Early the following morning this corn was delivered to retail stores. Followup visits to these stores revealed that the corn was received in excellent condition and produce buyers and store managers reported that they were highly pleased with the uniform high quality, especially the garden freshness.

The marketing specialist participated in 6 short courses; 21 county meetings with growers, shippers, and marketers; prepared 8 news articles; and distributed some 5,000 circular letters discussing these demonstrations and emphasizing the beneficial results obtained.

Some other States where educational and demonstrational work with sweet corn has been carried out include Maryland, New York, New Jersey, Minnesota, Wisconsin, Illinois, and Connecticut. However, much yet remains to be done to give the American consumers the garden fresh sweet corn which research and experimentation indicate are both feasible and desirable. It is only through an intensive, effective educational program that the time lag between the results of research and its application can be reduced to a minimum.

During the past year, Virginia, North Carolina, South Carolina, Georgia, Louisiana, Maryland, and New Jersey--only to mention the more important sweet potato producing States--carried on educational programs relating to grading, packing, storage, merchandizing, etc. In New Jersey, efforts were devoted to increasing sweet potato sales through better and more effective advertising, promotion and displaying. At the same time, work with growers stressed the need for central packing and better wholesale containers to improve quality. A sweet potato motion picture, prepared the year before, was used on several TV shows to assist with this educational program.

The extension marketing specialist in Georgia published a 35-page bulletin on marketing Georgia sweet potatoes and the extension marketing specialist in Virginia coauthored a Virginia joint agricultural publication on growing and selling sweet potatoes in Virginia. These publications have been used as a basis for marketing educational programs in Georgia and Virginia.

The educational work with roadside stand operators increased in 1953-54. Perhaps as a result of the continued decline in farm prices during the past year, more requests have come from growers to assist them in marketing their products through roadside markets. These educational programs have assisted growers with a more effective selling program in improving their roadside stand facilities and merchandising practices. In Massachusetts, over 100 roadside stand operators attended a series of meetings held by the extension marketing specialist. Visits to these and other operators by the specialist and county agents have indicated cleaning up of the grounds, continued improvements of signs, new stands being built, etc.

In California, a merchandising organization has been considered as a possibility of improving the merchandising programs of roadside stand operators.

A number of States, including Maryland, New Jersey, Michigan, New York, Florida--only to mention a few--have been assisted in one way or another with the development of plans for precooling strawberries and other fruits and vegetables. In Arkansas, a large proportion of the extension marketing specialist's time was devoted to meetings held in a number of the counties relative to the marketing of fruit and vegetable crops to processors.

Grading demonstrations were conducted in a number of the States last year. In Kentucky and Arkansas, commercial interests were assisted and advised in the establishment of freezing plants in areas where none existed.

Plans

With funds presently available, work during the coming year will continue with some additional emphasis.

EDUCATIONAL WORK WITH WHOLESALERS, RETAILERS, AND SECONDARY SUPPLIERS TO ENCOURAGE BETTER HANDLING AND MERCHANDISING METHODS AND PRACTICES

Progress and Findings - 1954 recommendation "Expand wholesaler-retailer training in the merchandising of fruits and vegetables."
(2/5)

Educational programs in food merchandising with retailers, wholesalers, and secondary suppliers were initiated in Delaware, Tennessee, Massachusetts, and Vermont.

Work under this phase of the extension program includes educational programs on merchandising principles, practices, and problems for food wholesalers, retailers, and their secondary suppliers that provides the stimulation and information from which practical results of competitive efficiency and expanded markets for food products can be realized.

In the retail distribution field there are approximately half a million food stores employing about $1\frac{1}{2}$ million people. The majority of these outlets are independently managed business operations that realize 62 percent of the total food sales. It is mostly with this group that adult educational programs can contribute continuing needed assistance in the areas of business management, personnel training, and overall merchandising efficiencies.

The corporate chains, while considerably less in number and total sales volume, can utilize the services of public educational agencies such as Extension, particularly with youth activities and market information.

While the program objective has been one of personal and immediate advantage to the market operator, reported results of this work indicate that growers and consumers receive benefits also. These results include adjustments in operating and merchandising methods and practices that have served to increase efficiency, lower merchandising costs, reduce spoilage losses, and increase sales. One county, for example, reports the expansion of community markets for graded packers and quality controlled fruits and produce, from local production alone, because of this newer educational activity.

During the past year, educational programs in food merchandising activities included some 16 States and 2 territories. Through the typical program of demonstrations, incorporated into informational meetings, longer term educational clinics and commodity merchandising programs, over 6 thousand local trade people were stimulated and helped to merchandise profitably more fresh fruits and vegetables, as well as other perishable foods during the past year.

Plans - With funds presently available, work will be expanded and intensified with retailers, wholesalers, and secondary suppliers to encourage better merchandising and handling methods, practices, and techniques.

EDUCATIONAL PROGRAMS ON MARKETING FACILITY IMPROVEMENTS

Progress and Findings - 1954 recommendation, "Expand educational work with marketing facilities improvement." (5/5)

Although no new projects in marketing facilities improvement have been initiated during the past year, much emphasis has been given this phase of work in California, North Carolina, Alabama, Tennessee, Wisconsin, New York, Massachusetts, Maryland, Virginia, Florida, Mississippi, Pennsylvania, Michigan, New Mexico, and Texas.

In many States during the past year, extension marketing specialists and county agents have been requested to conduct educational programs aimed toward improving marketing facilities. Since there is a rapid change in the producing areas for various vegetables, there is a need for new and additional facilities in some areas; while in others, the need for converting old facilities to other uses is acute. For example, in Massachusetts the extension marketing specialist has been requested to carry on educational work in the Connecticut Valley, as well as followup work on the wholesale produce market in Boston. In Pennsylvania, educational programs with farmers' markets assumed a place of importance. Farmers' markets constitute an important outlet for locally grown produce in many States and work with these markets has taken several forms.

For example, after several years of educational work during which market improvements were talked about and various meetings held, the Scranton market authorities finally decided to erect shelters overhead for the convenience of both buyer and seller. Marketing and agricultural engineering specialists worked in preparing specifications for several types of shelters. The extension marketing specialist met with the directors of the organization and advised them on what was being done in other States along direct marketing lines.

In Michigan, the extension marketing specialist met with the Michigan Market Managers' Association and kept them advised as to the trends in marketing facilities and various practices and methods.

Much of the extension marketing specialist's time is devoted to educational programs with county agricultural agents and other public workers in order to assist them with their local programs. The new farmers' market built in Lucedale, George County, Mississippi, in 1952, as a result of Extension AMA marketing work, has continued to grow this past year. The county agent and the extension marketing specialist have continued to work with the leaders and growers around the area of this market. The value of commodities marketed through the Lucedale marketing facility increased substantially during this past year. For example, 5 thousand acres of watermelons, 3 thousand acres crowder peas, butter beans, sweet peppers, and other vegetables and fruits were marketed through these facilities in 1953.

Plans - Increase emphasis in this work during the coming year as increased funds will permit.

EDUCATIONAL WORK WITH CONSUMERS

Progress and Findings - 1954 recommendation "Expand consumer education in the purchase and use of vegetables." (3/5)

Consumer education programs were initiated in Louisiana, Virginia, Tennessee, California, Illinois, Texas, North Dakota, and Indiana and intensified in Michigan, Wisconsin, and Kentucky.

Marketing information programs for consumers encourage more effective utilization of farm products. These programs benefit the consumers or customers who purchase food and also the merchants and farmers who are marketing these products.

Consumer education work in 28 States now cooperating in special AMA programs and 6 States with regular funds programs covers several of the large population centers but reaches only about 10 percent of our people. Radio, television, and newspapers are the usual means of presenting this information to the public. Food editors, health and welfare workers, schools, and public institutions also use this food marketing information.

Consideration is given to the following types of information:

1. Seasonally abundant supplies of food, marketing peaks, and shipment and price comparisons.
2. Selection of food, grades, quality, variety, new uses, and food preparation.
3. Marketing research, nutrition, and other information about food.

Satisfied customers will be better customers and will buy more of specific foods in season. It is the objective of this program to help consumers understand the food situation and to know the food they buy so they will be good customers. Favorable reports from consumers, merchants, and farmers indicate that this program has been helpful, but it needs to be expanded so as to reach more people.

Plans - Expand the program this year in line with additional funds that have been made available.

B. Proposals for Committee Consideration

Expand educational work carried out by the Cooperative Extension Service. Such expansion should include emphasis on educational work with:

- (A) Growers, marketing firms, and allied industry people to improve product quality through better grading, packing, containers, and other marketing methods, practices, and procedures.
- (B) Wholesalers, retailers, and secondary suppliers to encourage better merchandising and handling methods, practices, and techniques.
- (C) Growers and handlers to improve produce marketing facilities, operations, and methods.
- (D) Consumers, to include additional areas such as Cincinnati, Memphis, Portland, and New Orleans, where no program is now in operation and to intensify work in States where needed and desired.

